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IDENTIFIERS	Electrical Wiring; *Power Line Technicians

ABSTRACT

This module is the second in a series that is designed to help students achieve greater professional and personal success as power line technicians. Each module represents one or more complete units of instruction with components organized into one instructor and one student "package": the instructor's manual and the student workbook. The instructor's manual begins with a profile of training mastery that lists the competencies covered in the curriculum and provides space for recording information about the student's mastery of each objective. Other introductory matter includes information on use of the manual, recommendations for measuring student performance gains, and required criteria for a competency-based education program. The instructor's manual also contains one set per unit of these components: suggested activities, answers to assignment sheets, answers to test, transparency masters, and test. The student workbook contains one set per unit of most or all of these components: objective sheet, information sheets, assignment sheets, and job sheets. The nine units in this module are as follows: (1) personal and job safety, (2) communications, (3) basic electrical theory, (4) rope and rigging, (5) overhead construction, (6) underground distribution construction, (7) personal climbing tools and equipment, (8) right-of-way, and (9) distribution transformers. Most units are designed for use in more than one lesson or class period. (YLB)

ED 403 411

Power Line Technician
Second Edition

Module B

Instructor's Manual
Student Workbook

U.S. DEPARTMENT OF EDUCATION
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Power Line Technician

Second Edition

Module B

- Personal and Job Safety
- Communications
- Basic Electrical Theory
- Rope and Rigging
- Overhead Construction
- Underground Distribution Construction
- Personal Climbing Tools and Equipment
- Right-of-Way
- Distribution Transformers

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CIMC
Instructor's Manual
97-012265

Oklahoma Department of
Vocational and Technical Education
1500 West Seventh Avenue
Stillwater, OK 74074-4364
http://genesis.odvte.state.ok.us/cimc/home.htm
111016

POWER LINE TECHNICIAN
PROFILE OF TRAINING MASTERY

Instructor ______________________ Date ______________

Program ______________________

Grade __________ School ______________________

Name ______________________ Soc. Sec. No. ______________

Address ______________________ Phone ______________

In Case of Emergency, Contact ______________________

Address ______________________ Phone ______________

Allergies/Disabilities that might require special accommodation for training (please specify) __________

____

The above information can be used for school records and/or to ensure safety of students. This confidential information is not to be released to employers or the general public.

Date of Enrollment ___-___-___ Total Class Hours ______________ Total Hours Absent __________

Date of Withdrawal ___-___-___ Total On-the-Job Training Hours _______ Total Hours Tardy __________

Date of Completion ___-___-___ Total Lab Hours ______________

ON-THE-JOB TRAINING/WORK EXPERIENCE

Duration of Employment	Job Title	Supervisor's Name
Address of Employer		Phone
Duration of Employment	Job Title	Supervisor's Name
Address of Employer		Phone

Use of This Document

This document can be used to record information about the student and skills mastered. This information is useful in documenting student progress during training and in providing information about the student's qualifications to potential employers and/or for entry into advanced training programs. Instructors using these materials are authorized to reproduce this document as required for use in their training programs.

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Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education
1500 West Seventh Avenue, Stillwater, Oklahoma 74074-4364 1-800-654-4502 Fax 405-743-5154

SPECIFIC JOB COMPETENCIES

Instructor: As each competency is mastered, place your initials and the date in the blank on the left. This will verify that the student can perform the skill with a minimum of supervision.

MODULE A

Date/Initial

Unit 1 – Orientation to REC

1. Match terms associated with REC orientation to the correct definitions.
2. State the reason for establishing the Rural Electrification Administration.
3. Discuss the importance of rural electric cooperatives.
4. Describe the benefits of rural electric cooperatives to rural America.
5. Select from a list the finance agencies which loan money to rural electric cooperatives.
6. List types of electric utilities.
7. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 2 – Introduction to Power Line Technician's Training

1. List responsibilities of a line technician to the community.
2. Select from a list the responsibilities of a line technician to the employer.
3. Select from a list information that is shown on an organizational chart.
4. List departmental functions of a line department.
5. Select from a list topics taught in this course.
6. List benefits to students who complete the line technician's training course.
7. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 3 – Job Advancement

1. Match terms associated with job advancement to the correct definitions.
2. List characteristics employers consider when making promotions.
3. Distinguish between good and poor work attitudes.
4. List steps that will help in job advancement.
5. Select from a list benefits of additional education and training.
6. Discuss activities that will better prepare a person for advancement.
7. Discuss reasons people do not succeed on the job.
8. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 4 – General Safety

1. State the safety responsibilities of an REC employee.
2. List the steps of discipline for safety rule violations.
3. Select from a list items which are subject to safety rules.
4. State reasons for the importance of a safety policy.
5. Discuss OSHA regulations for first aid.
6. List the basic steps in first aid.
7. List steps of basic life support.
8. List first aid supplies.
9. List the practices for care of first aid supplies.
10. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

MODULE B

Date/Initial

Unit 1 – Personal and Job Safety

1. Match terms associated with personal and job safety to the correct definitions.
2. Describe the procedures to follow for various types of rescue situations.
3. List components necessary for fire.
4. Match classes of fires to the correct description of each.
5. Match types of fire extinguisher to the class or classes of fire each is best suited to extinguish.
6. List general safety precautions to observe during rescue.
7. Discuss in a short paragraph driving skills needed by a line technician.
8. List some poor attitudes that may cause accidents.
9. Select from a list requirements of a skilled driver.
10. List steps of defensive driving.
11. Identify shapes of traffic signs.
12. Select from a list some general safety precautions to observe when operating equipment.
13. State OSHA/DOT regulations for inspection of equipment.
14. Select from a list the items which should be inspected daily on mechanical equipment.
15. List methods for maintaining a clean and orderly work area.
16. Explain how to lift heavy objects.
17. Describe in a short paragraph the importance of safety communications.
18. Select from a list those items of importance that should be reported to the supervisor.
19. Select from a list items related to safety that a line technician should know concerning location and voltage.
20. State factors which determine the maximum weight which can be lifted by equipment.
21. Determine maximum weight that can be lifted by equipment at various angles.
22. Complete a safety pledge form.
23. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 2 – Communications

1. List types of communications necessary for an REC employee.
2. Select from a list those items of communication that are important between fellow workers.
3. List items of communication that are important between the worker and the supervisor.
4. Select from a list those items of communication that are important between the worker and the general public.
5. Identify hoist signals.
6. Identify winch line signals.
7. Identify hand signals used in boom operations.
8. Identify hand signals used when maneuvering vehicles.
9. Identify line work signals.
10. Select from a list the proper radio procedures.
11. State emergency radio procedure.
12. Select from a list the prohibited uses of the radio.
13. Match radio code signal numbers to the correct meanings.
14. List factors that are important when using cellular mobile telephones.
15. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Student ratings on specific competencies evaluated during the course are available upon student's written request and/or by calling the instructor. Parent's or guardian's signature is necessary if student is under 18 years of age.

BEST COPY AVAILABLE

Date/Initial

Unit 3 – Basic Electrical Theory

1. Match terms associated with basic electrical theory to the correct definitions.
2. List uses of electricity.
3. Discuss the electron theory.
4. Distinguish between alternating and direct current.
5. Match types of magnets to the correct descriptions.
6. State the law of magnetic poles.
7. Describe magnetic force as it relates to production of electricity.
8. Select from a list characteristics of electromagnetic force.
9. Explain the generation of electricity using magnets.
10. Describe electromagnetic induction.
11. Identify types of circuits.
12. Identify conditions of circuits.
13. Name sources of alternating and direct current.
14. Identify divisions of an electrical system.
15. State the relationship among amperage, resistance, and voltage.
16. Solve problems using Ohm's law.
17. Calculate for an unknown voltage.
18. Calculate for an unknown amperage.
19. Calculate for an unknown resistance.
20. ____________________

Pretest Score (%) ____________

Post Test Score (%) ____________

Modified Gains Score (%) ____________

Date/Initial

Unit 4 – Rope and Rigging

1. Match terms associated with rope and rigging to the correct definitions.
2. Identify parts of a stationary block.
3. List kinds of rope used in line work.
4. Determine the tensile strength of various kinds and sizes of rope.
5. Determine the mechanical advantage of using block and tackle.
6. List uses of various types of rope gear.
7. Apply the formula necessary for the safe working load of various kinds and sizes of ropes when given the tensile strength and safety factory.
8. Identify various knots and hitches.
9. Match various knots and hitches with the correct uses.
10. Identify elements of knots, bends, and hitches.
11. List conditions that damage rope.
12. Calculate the mechanical advantage of using block and tackle.
13. Calculate working load of various ropes.
14. ____________________

Pretest Score (%) ____________

Post Test Score (%) ____________

Modified Gains Score (%) ____________

Date/Initial

Unit 5 – Overhead Construction

1. Match terms associated with overhead construction to the correct definitions.
2. Match materials commonly used in overhead construction to their specific uses.
3. Identify hand tools commonly used in overhead construction.
4. Match hand tools to their specific uses.
5. Identify overhead construction tools.
6. Match overhead construction tools to their specific uses.
7. List elements of overhead construction.
8. List equipment used in overhead construction.
9. Match equipment commonly used in overhead construction to their specific uses.
10. Select from a chart the correct depth to set poles of varying lengths.
11. List methods used to properly sag conductors.
12. Identify various types of connectors used in overhead construction.
13. Match types of construction to the correct descriptions.
14. List steps to properly install a pole key.
15. State correct procedure for installing a ground rod.
16. Arrange in order the steps to follow when framing a pole.
17. Identify various structures used in transmission line construction.
18. ____________________

Pretest Score (%) ____________

Post Test Score (%) ____________

Modified Gains Score (%) ____________

Date/Initial

Unit 6 – Underground Distribution Construction

1. Match terms associated with underground construction to the correct definitions.
2. Identify equipment used in underground construction.
3. Match various types of equipment to the specific uses.
4. List general requirements for underground construction.
5. Arrange in order the correct procedure for installing cable.
6. List precautions to observe when handling underground cable.
7. Select from a list methods of marking cable for identification.
8. List methods used to locate and identify a utility ditch.
9. Identify equipment used to terminate primary cable on a pole.
10. State the requirement for grounding underground equipment.
11. List hazards which may be encountered in underground construction.
12. List precautions to observe when splicing or terminating cable.
13. Select from a list the tools used in underground construction.
14. Make a proper splice in secondary cable.
15. Make a proper splice in primary cable.
16. ____________________

Pretest Score (%) ____________

Post Test Score (%) ____________

Modified Gains Score (%) ____________

Date/Initial

Unit 7 – Personal Climbing Tools and Equipment

1. Match terms associated to personal climbing tools and equipment to the correct definitions.
2. Identify personal climbing tools and equipment.
3. Match tools and equipment to the specific use.
4. List conditions to watch for when inspecting personal climbing tools and equipment.
5. Name types of maintenance for personal climbing tools and equipment.
6. List safety precautions to observe when climbing poles.
7. Select from a list the general procedure for climbing poles.
8. Name rules for safe and proper storage of personal tools and equipment.
9. Climb poles.
10. ____________________

Pretest Score (%) ____________

Post Test Score (%) ____________

Modified Gains Score (%) ____________

Date/Initial

Unit 8 – Right-Of-Way

1. Match terms associated with right-of-way clearing and control to the correct definitions.
2. List methods to maintain good public relations.
3. Identify tools used for right-of-way clearing and control.
4. State the purposes of right-of-way control.
5. Select from a list the safe working procedures for right-of-way clearing and control.
6. Select proper methods of tree trimming.
7. List steps to remove limb hanging over an energized conductor.
8. List steps to fell a tree.
9. State the specifications for clearing right-of-way for distribution line.
10. List types of clearing and chemical control for right-of-way.
11. Identify various trees that grow rapidly.
12. Identify poisonous vegetation.
13. Draw cuts needed to remove heavy limbs.
14. Draw procedure for removing limb hanging over energized conductor.
15. Draw procedure for felling a tree.
16. ____________________

Pretest Score (%) ____________

Post Test Score (%) ____________

Modified Gains Score (%) ____________

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Date/Initial

Unit 9 – Distribution Transformers

1. Match terms associated with transformers to the correct definitions.
2. State the functions of a transformer.
3. Identify parts of a completely protected transformer.
4. Distinguish between additive and subtractive polarity as they relate to transformers.
5. List kinds of transformers.
6. Match types of transformers to the correct descriptions.
7. Classify types of transformers as oil-cooled or air-cooled.
8. Discuss technical considerations in protective grounding and jumpering.
9. List information found on a transformer nameplate.
10. ______

Pretest Score (%) ______

Post Test Score (%) ______

Modified Gains Score (%) ______

MODULE C

Date/Initial

Unit 1 – Poles

1. Match terms associated with poles to the correct definitions.
2. List five types of preservatives used on poles.
3. Match the type of preservatives used on poles with their code letters.
4. Select from a table the classes of poles of varying lengths and circumferences.
5. Select from a list precautions to observe when handling poles.
6. Calculate the weights of various classes and lengths of commonly used poles using a table.
7. List methods used to set poles.
8. State the correct procedure for checking a pole before climbing.
9. Arrange in proper order the steps for pole inspection.
10. List methods used to support unsafe poles for climbing.
11. State the correct method for storing poles.
12. Select from a table the classes of poles of varying lengths and circumferences.
13. Calculate the weights of various classes and lengths of commonly used poles using a table.
14. ______

Pretest Score (%) ______

Post Test Score (%) ______

Modified Gains Score (%) ______

Date/Initial

Unit 2 – Conductors

1. Match terms associated with line conductors to the correct definitions.
2. List methods used to protect line conductor at supports.
3. Arrange in order the steps to follow when joining ACSR conductors.
4. Arrange in order the steps to follow when joining CWC conductors.
5. List classes of conductors.
6. List methods of reeling our conductor.
7. Identify various types of conductor ties.
8. Match types of conductors to their specific use.
9. State conductor clearance from ground, roofs and building walls for conductors carrying 750 volts or less.
10. State conductor clearance from ground for conductors carrying over 750 volts to 22,000 volts.
11. Match current-carrying capacities of various ACSR conductors to the correct conductor size.
12. Match current-carrying capacities of various copperweld copper conductors to the correct conductor size.
13. Install a preformed line tie on ACSR conductor on a de-energized circuit.
14. Install a top groove conductor tie on a de-energized copper conductor.
15. Install a preformed armor rod on ACSR conductor.
16. Join ACSR conductor.
17. ______

Pretest Score (%) ______

Post Test Score (%) ______

Modified Gains Score (%) ______

Date/Initial

Unit 3 – Grounding and Connecting

1. Match terms associated with grounds and connectors to the correct definitions.
2. State the purposes of grounding.
3. List methods of grounding.
4. Select from a list those elements necessary for good grounding.
5. Select from a list equipment which must be grounded.
6. State the correct procedure for installing temporary protective grounds.
7. Arrange in order the steps to follow when disconnecting and grounding at sectionalizer or recloser station.
8. Arrange in order the steps to follow when disconnecting and grounding at multiphase vertical corner.
9. State the procedure for installing temporary protective grounds at air-break switch on a transmission line.
10. List elements of a good connection.
11. ______

Pretest Score (%) ______

Post Test Score (%) ______

Modified Gains Score (%) ______

Date/Initial

Unit 4 – Generators and Batteries

1. Match terms associated with generators and batteries to the correct definitions.
2. List kinds of generating plants.
3. Match kinds of generators to the voltages produced by each.
4. Match kinds of generators to the specific uses.
5. Calculate the frequency (Hertz) of various generators.
6. List precautions to observe with the use of portable generators.
7. List types and kinds of voltage-producing cells.
8. Identify various circuits of connected batteries.
9. Select from a list precautions to observe when connecting batteries.
10. Arrange in order the steps to follow to connect lead-acid batteries when starting equipment.
11. Connect batteries in series and parallel.
12. ______

Pretest Score (%) ______

Post Test Score (%) ______

Modified Gains Score (%) ______

Date/Initial

Unit 5 – Work Procedures (Nonenergized)

1. Match terms associated with work procedures to the correct definitions.
2. Select from a list information found on a staking sheet.
3. Arrange in proper order the procedure for line construction.
4. List steps to follow when installing service wire.
5. State the procedure for connecting service wire.
6. Match the materials needed to construct primary and neutral assemblies using ACSR conductor 7.2kV construction.
7. List materials needed to install various pole ground assemblies.
8. List materials needed for various primary assemblies.
9. List materials needed to complete a work order.
10. Identify section numbers within a township.
11. Locate rural property in Oklahoma using legal descriptions.
12. ______

Pretest Score (%) ______

Post Test Score (%) ______

Modified Gains Score (%) ______

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MODULE D

Date/Initial

Unit 1 – Insulation

1. Match terms commonly associated with insulators and insulation to their correct definitions.
2. List steps to follow when installing a pin type insulator.
3. Select from a list methods of insulating distribution voltages.
4. Select from a list methods of insulating various transmission voltages on wooden structures.
5. Match insulative materials to their specific uses.
6. Select from a list precautions to observe with insulators and insulation.
7. ______________________________

Pretest Score (%) ____________________

Post Test Score (%) ____________________

Modified Gains Score (%) ____________________

Date/Initial

Unit 2 – Substations

1. Match terms commonly used with substations to the correct definitions.
2. State functions of a substation.
3. Identify components of a substation.
4. Match components of a substation to their specific use.
5. Arrange in order the steps for taking a substation out of service.
6. Select from a list precautions to observe with a substation.
7. Arrange in order the correct procedure for changing a substation oil circuit recloser.
8. State the correct procedure for bypassing a substation current transformer.
9. List indications in a substation that could cause an outage.
10. Match indications to problems which may occur in substations.
11. ______________________________

Pretest Score (%) ____________________

Post Test Score (%) ____________________

Modified Gains Score (%) ____________________

Date/Initial

Unit 3 – Ground and Jumpers (Line Equipment)

1. Match terms commonly used with grounds and jumpers to the correct definitions.
2. Match types of jumpers to their specific use.
3. State requirements for various jumpers.
4. Select from a list the line equipment that is connected by jumpers.
5. Match types of jumpers to the correct installation methods.
6. State the requirements for safe grounding of line equipment.
7. Distinguish between proper and improper grounding methods.
8. Calculate current flow of faulted equipment which is improperly grounded.
9. Calculate voltage on improperly grounded faulted equipment.
10. ______________________________

Pretest Score (%) ____________________

Post Test Score (%) ____________________

Modified Gains Score (%) ____________________

Date/Initial

Unit 4 – Voltage and Current Measuring

1. Match terms commonly used with voltage and current measurements to the correct definitions.
2. State the purposes of voltage and current measurements.
3. Identify equipment used for voltage and current measurements.
4. State the correct procedure for determining voltage drop of a service.
5. State the correct procedure for determining current demand on a primary circuit in a specific area.
6. State procedures for determining current demand on a transformer.
7. List steps to obtain primary line voltage drop.
8. Select from a list reasons for current measurements.
9. Match full load secondary current at 240 volts single phase to the kVA ratings of a transformer.
10. Select from a list precautions to observe when making voltage and current measurements.
11. ______________________________

Pretest Score (%) ____________________

Post Test Score (%) ____________________

Modified Gains Score (%) ____________________

MODULE E

Date/Initial

Unit 1 – Meters and Meter Application

1. Match terms commonly associated with metering to the correct definitions.
2. List general types of meters.
3. List types of meters by base construction.
4. List classes of meters and the current-carrying capacity of each.
5. Match meters to types of service.
6. Match meter to voltage ratings to types of service.
7. Match abbreviations and symbols used with metering circuit diagrams to the correct meanings.
8. List uses of current transformer metering.
9. List uses of self-contained meter connections.
10. Identify various self-contained meter connections.
11. Identify various transformer-rated meter connections.
12. Identify various transformer-rated meter connections for 600 volts or above.
13. State the procedure for selecting the correct meter.
14. List methods for determining voltage for wye and delta connected meters.
15. Match types of services to specific uses.
16. List types of meters which have multipliers.
17. Arrange in order the correct procedure for determining meter mutipliers.
18. List precautions to observe with metering.
19. Calculate the multiplier for a transformer-rated meter connected to a secondary line.
20. Calculate the multiplier for a transformer-rated meter connected to a primary line.
21. ______________________________

Pretest Score (%) ____________________

Post Test Score (%) ____________________

Modified Gains Score (%) ____________________

Date/Initial

Unit 2 – System Knowledge

1. Match terms used with system knowledge to the correct definitions.
2. Define symbols used with overhead lines and equipment identification on system maps.
3. Define symbols used with underground lines and equipment identification on system maps.
4. Identify symbols used to locate cultural features on system maps.
5. List functions of automated equipment.
6. List precautions to observe with automated equipment.
7. Select from a list conditions associated with system terrain.
8. Identify symbols on a system map.
9. ______________________________

Pretest Score (%) ____________________

Post Test Score (%) ____________________

Modified Gains Score (%) ____________________

8

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Date/Initial

Unit 3 – Transformer Connections and Banking

1. Match terms commonly used with transformer connections and banking to the correct definitions.
2. Define characteristics of transformer construction.
3. Match symbols used with transformer voltage rating and connection diagrams to the correct meanings.
4. Discuss transformer polarities.
5. Discuss bushing locations in relationship to polarity on padmount transformers and compare to pole-type in regard to subtractive and additive.
6. Identify secondary coil connections for two- and three-wire service.
7. Identify single-transformer connections for three-wire service.
8. Identify two-transformer banks.
9. Define objectives an electrician must keep in mind when constructing three-phase banks.
10. List in order the step-by-step process for designing three-phase banks.
11. Describe phase relationships between the bushings in three-phase banks.
12. Identify types of primary and secondary connections for three-transformer banks.
13. List precautions to observe when selecting transformers to be banked or paralleled.
14. Identify secondary connections on a four-bushing transformer.
15. State the correct method of connecting wye and delta transformers to a primary line.
16. Arrange in order the steps to find a faulted transformer in a bank.
17. State the precautions to observe with transformer banks.
18. Connect transformer secondary coils in series and parallel.
19. Connect a wye-delta bank for three-phase four-wire 120/240-volt service.
20. Connect a wye-delta bank for three-phase three-wire 240-volt service.
21. Connect a wye-wye bank for three-phase four-wire 120/208-volt service.
22. Connect an open-wye open-delta bank for three-phase four-wire 120/240-volt service.
23. Connect an open-wye open-delta bank for three-phase three-wire 240-volt service.
24. Connect an open-delta open-delta bank for three-phase four-wire 120/240-volt service.
25. Connect two single-bushing transformers in parallel.
26. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 4 – Phasing

1. Match the terms commonly associated with phasing to the correct definitions.
2. List elements of phasing.
3. State methods of determining phase rotation.
4. State the procedure for changing the direction of rotation of a three-phase motor.
5. Arrange in order the steps to follow when phasing circuits with a phasing meter.
6. Arrange in order the steps to follow to identify distribution phases.
7. Label substation distribution phases.
8. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

MODULE F

Date/Initial

Unit 1 – Line Patrol

1. Match types of line patrol to the specific purpose.
2. Select from a list items to observe when patrolling line.
3. Match items to the specific conditions to observe when patrolling a line.
4. List methods of line patrol.
5. Select from a list requirements of a line patroller.
6. List items to observe with line equipment.
7. Complete a line inspection form.
8. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 2 – Electrical Equipment

1. Match terms used with electrical equipment to the correct definitions.
2. Match electrical equipment to the specific uses.
3. Arrange in order the steps to follow when connecting a voltage regulator to a three-phase line.
4. Arrange in order the steps to follow when placing a voltage regulator in service.
5. State the procedure for setting voltage regulator time delays.
6. State the procedure for taking a voltage regulator out of service.
7. List precautions to observe with voltage regulators.
8. List precautions to observe with capacitors.
9. Select from a list the benefits of capacitor application.
10. Name equipment that should be protected by lightning arresters.
11. Explain the method of coordinating reclosers with other reclosers.
12. List precautions to observe when installing sectionalizers.
13. Select from a list factors to consider when coordinating reclosers and fuses.
14. Connect voltage regulators to a three-phase line.
15. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 3 – Work Procedures (Hot Line, Basket, Hot Stick)

1. List methods of hot line maintenance.
2. Select from a list OSHA requirements for aerial devices.
3. Select from a list rules to observe when working with aerial devices.
4. List elements of hot line maintenance.
5. State the procedure for hot line maintenance from an aerial device.
6. Arrange in order the steps to follow when changing a pole top insulator from a basket.
7. Match various hot line tools to their specific uses.
8. Install a wire tong saddle.
9. Change an insulator on an energized conductor using hot line tools on an A1 structure.
10. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

Date/Initial

Unit 4 – Troubleshooting (Secondary)

1. Match terms associated with troubleshooting to the correct definitions.
2. Match indications of malfunctions to the possible causes.
3. Arrange in order the correct procedure for troubleshooting electrical equipment.
4. List precautions to observe when troubleshooting electrical equipment.
5. Select from a list items of information to obtain while troubleshooting.
6. ______________________

Pretest Score (%) ______________

Post Test Score (%) ______________

Modified Gains Score (%) ______________

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MODULE G

Date/Initial

Unit 1 – Troubleshooting (Primary Line)

____________ 1. Match troubleshooting problems to possible causes.
____________ 2. Arrange in order the troubleshooting procedures to follow for various problems.
____________ 3. List precautions to observe when troubleshooting primary lines.
____________ 4. Arrange in order the steps for troubleshooting a primary line outage.
____________ 5. ____________________________

Pretest Score (%) ____________________
Post Test Score (%) ____________________
Modified Gains Score (%) ____________________

Date/Initial

Unit 2 – System Knowledge

____________ 1. List problems associated with line switching.
____________ 2. Arrange in order the steps to follow when switching line.
____________ 3. List factors involved in line switching.
____________ 4. Select from a list precautions to observe with line voltage regulators on a switched line.
____________ 5. List precautions to observe when opening a line switch.
____________ 6. Select from a list areas and locations of importance to the line technician.
____________ 7. ____________________________

Pretest Score (%) ____________________
Post Test Score (%) ____________________
Modified Gains Score (%) ____________________

Date/Initial

Unit 3 – Conversions

____________ 1. List types of conversions.
____________ 2. Arrange in order the steps to convert a primary line to a higher voltage.
____________ 3. Arrange in order the steps to change a substation feed area to a higher voltage.
____________ 4. Explain benefits of converting to a higher voltage.
____________ 5. Select from a list precautions to observe with autotransformers.
____________ 6. Arrange in order the steps to convert a single-phase line to V-phase.
____________ 7. Arrange in order the steps to convert a single-phase line to three-phase.
____________ 8. ____________________________

Pretest Score (%) ____________________
Post Test Score (%) ____________________
Modified Gains Score (%) ____________________

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Power Line Technician: Module B

Instructor's Manual

Upfront

Suggested Activities

Answers to Assignment Sheets

Answers to Test

Transparency Masters

Test

Developed by the
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education

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Curriculum and Instructional Materials Center

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Measuring Student Performance Gains xiii
Required Criteria for a Competency-Based Education Program xv
Corrections and Suggestions xvii

One set per unit of the following components:

- Suggested Activities
- Answers to Assignment Sheets
- Answers to Test
- Transparency Masters
- Test

Student Workbook

One set per unit of Objective Sheets, Information Sheets, Assignment Sheets, and Job Sheets for each of the units in this module:

MODULE A

1. Orientation to REC
2. Introduction to Power Line Technician's Training
3. Job Advancement
4. General Safety

MODULE B

1. Personal and Job Safety
2. Communications
3. Basic Electrical Theory
4. Rope and Rigging
5. Overhead Construction
6. Underground Distribution Construction
7. Personal Climbing Tools and Equipment
8. Right-of-Way
9. Distribution Transformers

MODULE C

1. Poles
2. Conductors
3. Grounding and Connecting
4. Generators and Batteries

5. Work Procedures (Nonenergized)

MODULE D

1. Insulation
2. Substations
3. Grounds and Jumpers (Line Equipment)
4. Voltage and Current Measuring

MODULE E

1. Meters and Meter Application
2. System Knowledge
3. Transformer Connections and Banking
4. Phasing

MODULE F

1. Line Patrol
2. Electrical Equipment
3. Work Procedures (Hot Line, Basket, Hot Stick)
4. Troubleshooting (Secondary)

MODULE G

1. Troubleshooting (Primary Line)
2. System Knowledge (Phase II)
3. Conversions

FOREWORD

The *Power Line Technician* series is designed to help students achieve greater professional and personal success. As a tool for building a rewarding career, this series will help students develop their professional competence. In addition, the series provides a foundation for career advancement. The *Power Line Technician* series consists of seven modules which address specific skill areas. Each module represents one or more complete units of instruction with components organized into one student and one instructor "package": the *Student Workbook*, and the *Instructor's Manual*. We believe the format and packaging will facilitate both the delivery and mastery of the identified competencies.

We hope that this series will enhance instruction and contribute to rewarding learning experiences for all students.

Roy Peters, Jr.
State Director
Oklahoma Department of
Vocational and Technical Education

Ivan Armstrong
State Supervisor
Trade and Industrial Education

ACKNOWLEDGMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to the individuals who played key roles in the development of this publication. Such a comprehensive effort requires contributions from many people. We sincerely appreciate the support necessary to complete this project.

Design:	Special thanks are extended to the representatives from industry, teaching, and vocational education who participated as members of the curriculum advisory committees for the *Power Line Technician* series. We also thank the administrators, supervisors, and others who supported their participation. Significant contributions were made during the revision process by participants from ABB Power T&D Company Inc., the Association of Missouri Electric Cooperatives, the Central Rural Electric Cooperative (Stillwater, Oklahoma) and the City of Stillwater.
Development:	The modules in this series were edited by Craig Maile and Dr. Lois Sharpton. Individual modules were formatted by Vonda Gile. Brenna Tillman, Publications Supervisor in the CIMC, assisted in adapting the packaging.
Production:	The close cooperation and dedication of professionals at the Oklahoma Department of Vocational and Technical Education were instrumental in producing the *Power Line Technician* series. Unit and cover artwork were designed by the Art Department, under the direction of Bob Davis, Art Manager. This series could not have been printed without the expertise and commitment of the Printing Plant Staff, under the direction of Danny Darrow. Delivering the final product was accomplished through the excellence of the CIMC Customer Service staff and the staff of the CIMC Warehouse, under the direction of Darrell Stiles.
Support:	A number of people at the CIMC helped to make this series possible. Terri Tomson efficiently handled the development contracts, committee meetings, and correspondence relating to this series. This project also received generous support from John Friedemann, CIMC Team Leader, and Dr. Lynna Ausburn, Development Coordinator.
Project Management:	Dr. Marilyn Troupe and Craig Maile

USE OF THIS PUBLICATION

Each unit of instruction is based on the performance needed for successful employment in an occupational area. A complete unit will contain most or all of the following components: Objective Sheet, Suggested Activities, Information Sheet, Assignment Sheet, Job Sheet, Test, Answers to Assignment Sheets, Answers to Test, and Transparency Masters. These components are organized within two packages, as follows:

Instructor's Manual

- Upfront pages
- One set per unit of:
  - Suggested Activities
  - Answers to Assignment Sheets
  - Answers to Test
  - Transparency Masters
  - Test

Student Workbook

- Objective Sheets
- Information Sheets
- Assignment Sheets
- Job Sheets

Instructor's materials include the *Instructor's Manual* and the *Student Workbook*.

Unit components are tied to measurable and observable learning outcomes. Instructors are encouraged to supplement unit components with other resources to make units as responsive to local conditions and student needs as possible.

Most units of instruction are designed for use in more than one lesson or class period. Instructors should determine the following for each unit:

- amount of material that can be covered in each class period;
- skills that must be demonstrated;
- supplies and equipment needed;
- amount of class time needed for demonstrations;
- amount of class time needed for student practice;
- supplementary materials to be ordered; and
- resource persons who must be contacted.

Objective Sheet (Student Workbook)

The Objective Sheet summarizes each unit for the student and the instructor. The Objective Sheet includes the following sections:

> **Unit Objective** – The Unit Objective states the overall goal of the unit. It identifies what the student will be able to do after successfully completing the unit, as well as the standards used to measure student performance.
>
> **Specific Objectives** – The Specific Objectives outline the teaching sequence of the competencies required to reach the Unit Objective.

The Specific Objectives on the Objective Sheet should be emphasized to all students at the start of each unit and throughout the teaching/learning process. This will help answer student questions about performance requirements for each unit. Specific Objectives can also assist instructors in determining teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could best be taught.

Instructors should modify, delete, or add objectives to meet the needs of students and the community. When objectives are added, the instructor should remember to provide the needed information, Assignment and/or Job Sheets, and criterion-referenced test items to cover the new objectives.

Information Sheet (Student Workbook)

The Information Sheet provides the "must know" content essential for meeting the cognitive objectives in the unit. The Information Sheet may include clarifying NOTES and EXAMPLES, as needed. Students should read the Information Sheet for each unit before it is discussed in class.

Assignment Sheets (Student Workbook)

The Assignment Sheets address the learning levels at or above the application level of Bloom's taxonomy. They allow students to perform non-psychomotor activities related to occupational tasks. Assignment Sheets also provide students with an opportunity to use higher-order thinking skills, such as problem-solving, synthesizing, analyzing, and evaluating. In addition, they may provide opportunities for cooperative learning and more detailed oral/written communication activities.

Job Sheets (Student Workbook)

Job Sheets give students step-by-step procedures for performing manipulative or psychomotor occupational tasks or jobs. The Job Sheet also facilitates the instructor's evaluation of each student's performance. Both the process and the end-product are evaluated. Diagrams, illustrations, and photographs are included, as needed, to assist students in completing the job.

The instructor should demonstrate the procedure outlined in each Job Sheet. Instructors may also have to localize specific procedures.

Suggested Activities (Instructor's Manual)

Instructors should study the Suggested Activities before introducing the unit, allowing enough time to obtain supplemental materials, prepare audiovisual materials, and contact outside resource persons. Specific tasks of the instructor will vary with each unit.

Answers to Assignment Sheets and Answers to Test (Instructor's Manual)

These components list the answers to all of the Assignment Sheets and the Test questions.

Transparency Masters (Instructor's Manual)

Transparency Masters are provided so that instructors can make transparencies to accompany specific units. Transparencies allow students to *see* as well as hear the information being presented, thus reinforcing the learning process. They also direct attention to the topic under discussion. Transparencies should be left on the screen only when the related topics are under discussion.

Test (Instructor's Manual)

The Test provides criterion-referenced evaluation of the Specific Objectives from the Information Sheet (Assignment Sheet and Job Sheet objectives are not evaluated by the Test). If instructors have added, deleted, or modified any objectives, appropriate changes should be made to the Test as well.

The Test serves as both a pretest and a posttest. In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *essential* that the same test be used as a pretest and as a posttest. If instructors choose to use tests other than the unit Test, they should make sure that the same instrument is used for each activity – pre- and posttest.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* This booklet – and accompanying software to assist in calculating and recording student gains – are available to Oklahoma instructors through their school's vocational testing liaison.

Profile of Training Mastery

The Profile of Training Mastery documents student performance. Each profile lists the competencies covered in the curriculum, and provides space for recording information about the student and the student's mastery of each objective. Space is also provided for recording pre- and posttest scores, modified gains, and instructor comments. A blank Profile of Training Mastery is available for this series. It may be reproduced for each student.

Page Numbering

Each Module is identified with a letter (A - G). Each unit and page has a number, shown in Arabic numerals. For example, the page number for Module A, Unit 2, page 3 of the *Student Workbook* would appear as follows:

PLT A - 2 - 3

Methods of Disseminating Material

For best results, provide each student with a copy of the Student Workbook. Students should be allowed to keep their Workbooks at the end of the course or training program.

Teaching Methods

Keeping students motivated is a challenge. Supplement each unit with current information, personal experiences, and other information. In a group setting, prepare for each unit by determining the best way to teach each objective, and allow for student input. For individualized instruction, provide opportunities for the student to become involved in planning and being responsible for his or her own education.

MEASURING STUDENT PERFORMANCE GAINS

Each CIMC unit contains only a single unit Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach*. In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	**Discussion**	**CIMC component meeting criterion**
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives.	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Test and Job Sheet

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Profile of Training Mastery

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with accurate and effective materials. Although the CIMC strives to maintain the highest standards of development and production, oversights sometimes do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. To do this, please identify the page(s) affected and write any comments to clarify the error or suggestion. Use the spaces below. Then, simply fold (bottom of page *upward*, top *downward*), secure, and mail.

This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

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Page: Comment:

1 Fold upward

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27

PERSONAL AND JOB SAFETY
UNIT 1

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objective sheet.
   - Provide student with information and assignment sheets.
   - Make transparencies.
   - Discuss unit and specific objectives.
   - Discuss information and assignment sheets.
   - Show film and other supplemental material on safety.
   - Give test.

2. Unit references:

   - *Oklahoma Driver's Manual.* Oklahoma City: Oklahoma Department of Public Safety, 1992.
   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

PERSONAL AND JOB SAFETY
UNIT 1

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. 15 feet
2. 3200 pounds
3. 10,800 pounds
4. 500 pounds

Assignment Sheet 2

Completed Safety Pledge Form

PERSONAL AND JOB SAFETY
UNIT 1

ANSWERS TO TEST

1. a. 13
   b. 10
   c. 7
   d. 8
   e. 9
   f. 11
   g. 5
   h. 3
   i. 1
   j. 4
   k. 6
   l. 2
   m. 12
   n. 14

2. a. Pole top
      1) Remove electrical source from victim
      2) Restore breathing
      3) Lower victim to ground

   b. Energized vehicle
      1) Disconnect or remove source of electricity
      2) Have fire extinguisher ready for use
      3) Clear all lines from vehicle

   c. Electric shock
      1) Remove source of electricity
      2) Check pulse and respiration
      3) Begin CPR if needed

   d. Aerial device
      1) Be sure vehicle is not energized
      2) Lower platform or basket with override controls

ANSWERS TO TEST

- 3) Remove victim from platform or basket
- 4) Check victim for injuries, pulse, and respiration and begin CPR if needed

e. Fire

- 1) Place thick wet cloth over mouth and nose
- 2) Check doors for extreme heat before opening
- 3) Crouch low and stay behind door when opening

3. a. Fuel
   b. Heat
   c. Oxygen

4. a. 1
   b. 3
   c. 4
   d. 2

5. a. 2, 3
   b. 1, 3, 4
   c. 1, 4
   d. 1

6. (NOTE: Any three of the following are acceptable.)
   a. Do not endanger yourself just to be a hero
   b. Acquire the tools or equipment needed to carry out a rescue
   c. Follow safety procedures
   d. Notify proper authority
   e. Request assistance if needed

7. a. Obey all traffic laws
   b. Respect the rights of others

ANSWERS TO TEST

- c. Drive defensively
- d. Use seat belts
- e. Practice good housekeeping
- f. Be aware of vehicle limitations
- g. Drive only in areas where vehicle damage will not occur

8. (NOTE: Any three of the following are acceptable.)
   - a. Accidents happen to the other guy
   - b. Shortcuts save time
   - c. Safety rules are for other people
   - d. Breaking safety rules is alright if you don't get caught
   - e. I have done this before and didn't get hurt
   - f. Speeding is alright if you are a good driver

9. a, c, d, e, f, g, h, i, k, l, m

10. a. Aim high in steering
   - b. Get the big picture
   - c. Keep eyes moving
   - d. Leave yourself an out
   - e. Make sure other drivers see you

11. a. Stop
   - b. Railroad crossing
   - c. Yield right-of-way
   - d. Warning
   - e. School area
   - f. Regulatory
   - g. Service and guide

ANSWERS TO TEST

12. a, b, c, e, f, g, h, i, j

13. a. Inspection prior to each use by competent person designated by employer

    b. Annual inspection by competent person, government agency, or private agency recognized by the Department of Labor

14. a. 1, 2, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16

    b. 1, 3, 4, 5, 6, 7, 9, 10, 11

15. (NOTE: Any three of the following are acceptable.)

    a. Store equipment that is not in use

    b. Stack packing materials and boxes and dispose of properly

    c. Place materials in proper storage area after removing from job

    d. Keep scrap and excess wire picked up and stored in proper place

    e. Pick up all litter

    f. Place all combustible or hazardous materials in proper containers

    g. Place covers, guards, shields provided on all sharp, pointed or cutting edges

16. In any order:

    - Lift with legs, not with back
    - Keep back straight
    - Do not lift heavy objects without help

ANSWERS TO TEST

17. Communications with other crews, co-workers, and supervisor aid in accident prevention.

18. a, b, c, d, f, g, h

19. a. 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13 14

    b. 1, 3, 4, 5, 6, 7

20. a. Design

    b. Degree of elevation of lifting boom

    c. Size and condition of cable

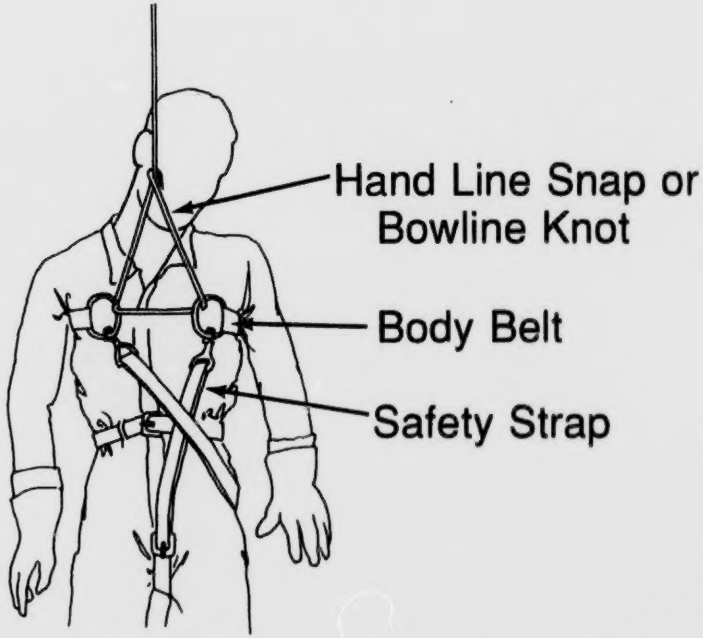
    d. Rating

    e. Terrain

21. Evaluated on Assignment Sheet 1.

22. Evaluated on Assignment Sheet 2.

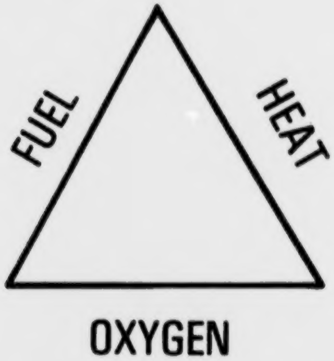
Lowering Victim To Ground


Hand Line Snap or Bowline Knot
Body Belt
Safety Strap

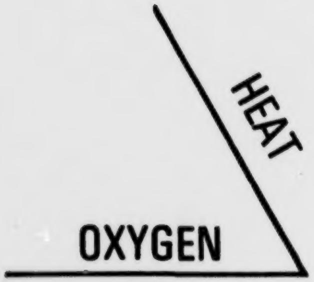
(NOTE: A hand line only may be used to quickly remove victim from pole.)

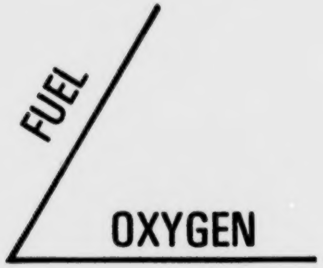
The Fire Triangle

To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.


HEAT
OXYGEN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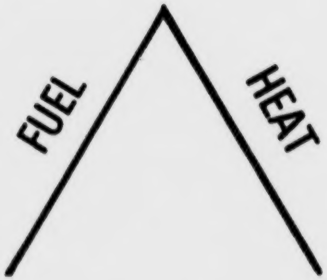
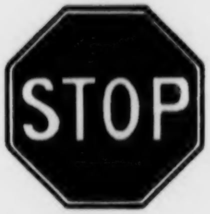
OXYGEN

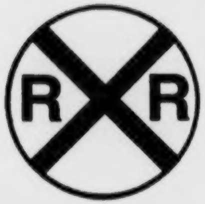


May be photocopied for student use.

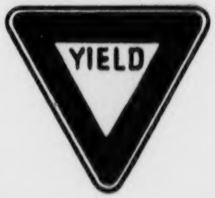
Traffic Signs



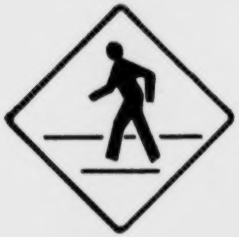
Stop



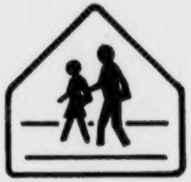
Railroad Crossing



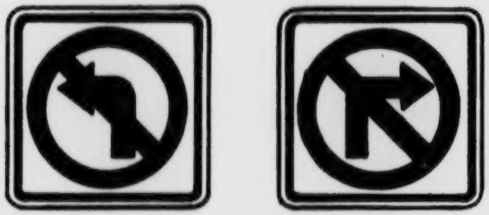
Yield Right-of-Way



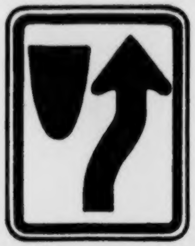
Warning



School Area



Regulatory



Service and Guide

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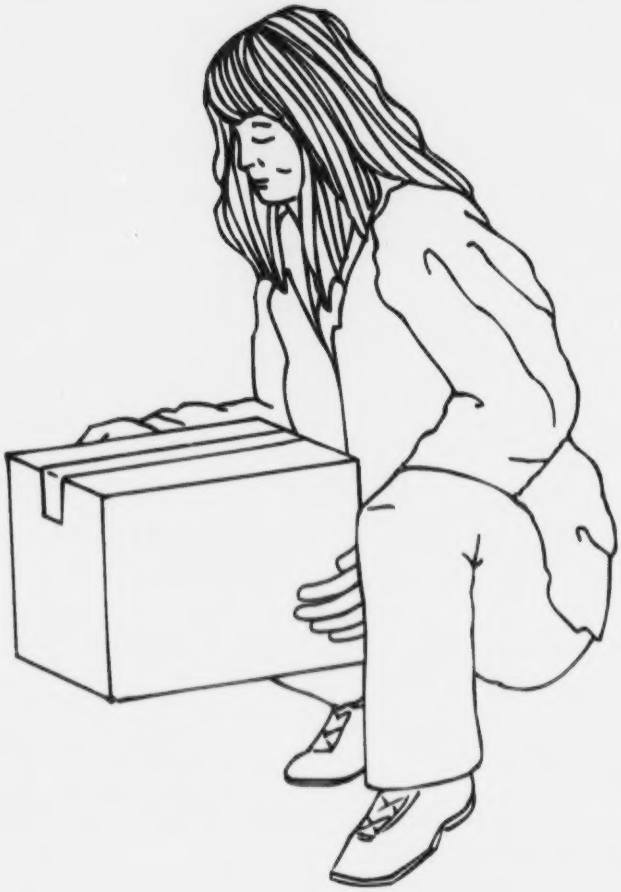
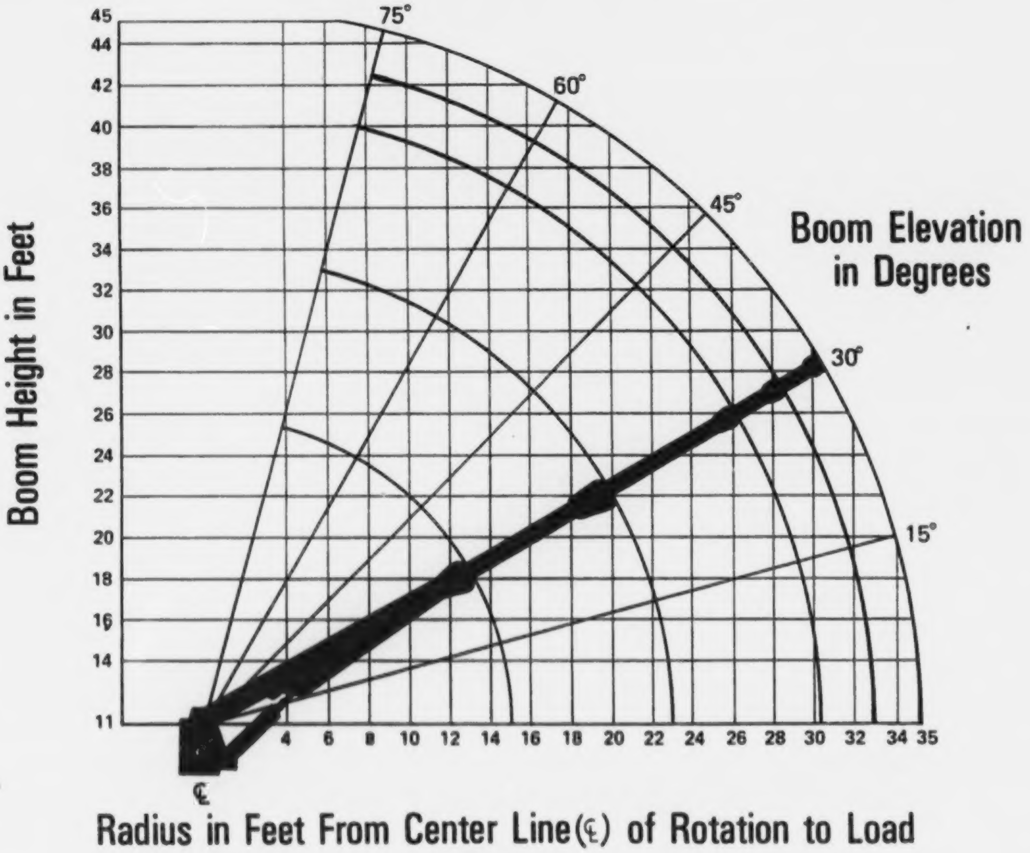
Correct Way To Lift Heavy Objects



TM 4

May be photocopied for student use.

Capacity Chart



BOOM RETRACTED	LOAD RADIUS	4	5	6	8	10	12	15
	LOAD	11000	10000	8800	7400	6400	5600	4300

Deduct approx. 1000 pounds when equipped with digger.

BOOM EXTENDED	LOAD RADIUS	8	10	12	14	16	18	20	23
	LOAD	6200	5300	4600	4200	3800	3500	3200	2600

Deduct approx. 600 pounds when equipped with digger.

INSULATED BOOM EXTENSION	LOAD RADIUS	10	14	18	22	26	28	30	33	35
	LOAD	4500	3400	2900	2400	2200	2000	1800	1500	1200

Deduct approx. 500 pounds when equipped with digger.

DEDUCT 200 POUNDS FROM ALL CHARTS WHEN EQUIPPED WITH POLE CLAW.

PERSONAL AND JOB SAFETY
UNIT 1

TEST

NAME ____________________ SCORE __________

1. Match the terms on the right to the correct definitions.

_____a. Consistent use and care of items intended for use as safeguards

_____b. Federal legislation designed to insure safe and sanitary working conditions for employees

_____c. Mental position regarding an act or state

_____d. Procedure of freeing from imminent danger by prompt action

_____e. Act of viewing closely in critical appraisal

_____f. Proper use, care, and inspection of equipment

_____g. Series of steps followed in a definite order

_____h. Manual method of sustaining life until advanced life support system is available

_____i. Unplanned or unscheduled event which may or may not cause personal injury or property damage

_____j. Equipment worn on or about the body to help prevent bodily injury

_____k. Measure taken beforehand to prevent harm or damage

_____l. Immediate and temporary care of an accident or sudden illness victim until the service of a physician is obtained

_____m. Following procedures, codes, and methods prescribed in safety standards

_____n. State or condition of being safe; freedom from danger, risk, or injury

1. Accident
2. First aid
3. Basic life support
4. Personal protective equipment
5. Procedure
6. Precaution
7. Attitude
8. Rescue
9. Inspection
10. OSHA (Occupational Safety and Health Act)
11. Equipment safety
12. Job safety
13. Personal safety
14. Safety

TEST

2. Describe the procedure to follow for each of the rescue situations listed below.

   a. Pole top

   ____

   ____

   ____

   b. Energized vehicle

   ____

   ____

   ____

   c. Electric shock

   ____

   ____

   ____

   d. Aerial device

   ____

   ____

   ____

   e. Fire

   ____

   ____

   ____

3. List the three components necessary for fire.

   a. ____________

   b. ____________

   c. ____________

May be photocopied for student use.

TEST

4. Match the classes of fire on the right to the correct descriptions.

_____a. Fires that occur in ordinary combustible material such as wood, rags, and rubbish

_____b. Fires that occur in or near electrical equipment such as motors, transformers, switchboards, and electrical wiring

_____c. Fires that occur with combustible metals such as iron and magnesium

_____d. Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners

1. Class A
2. Class B
3. Class C
4. Class D

5. Match the types of fire extinguisher on the right to the class or classes of fire each is best suited to extinguish. Blanks may have more than one answer.

_____a. Class A fire

_____b. Class B fire

_____c. Class C fire

_____d. Class D fire

1. Dry chemical
2. Pressurized water
3. Foam
4. Carbon dioxide

6. List three general safety precautions to observe during rescue.

a. ____

b. ____

c. ____

7. Discuss in a short paragraph the driving skills needed by a line technician.

____

____

____

____

____

TEST

8. List three poor attitudes that may cause accidents.

a. ______________________________

b. ______________________________

c. ______________________________

9. Select from the following list those statements that are requirements of a skilled driver by placing an "X" in the blanks provided.

_____a. Passes other vehicles only when there is sufficient distance to do so safely

_____b. Exceeds speed limit only when passing other vehicles

_____c. Allows no one to ride outside of vehicle

_____d. Keeps transmission engaged when descending grades

_____e. Maintains good visibility

_____f. Sets parking brake, places transmission in gear, and chocks wheels when parking on a grade

_____g. Places flares or reflectors if vehicle is stalled

_____h. Attaches red flag to load if extended four feet or more beyond truck body

_____i. Yields to avoid an accident even if he/she has the right-of-way

_____j. Obeys most traffic laws

_____k. Follows other vehicles at a safe distance

_____l. Checks to the rear before backing

_____m. Maintains current and proper class Commercial Driver's License

_____n. Signals intent when turning, changing lanes, or stopping

_____o. Allows no one to mount or dismount while vehicle is in motion

_____p. Obeys all state and local traffic laws

TEST

10. List the five steps of defensive driving.

a. ______________________________

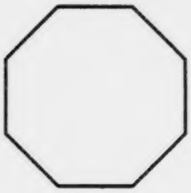
b. ______________________________

c. ______________________________

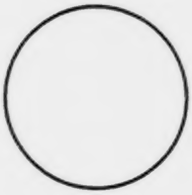
d. ______________________________

e. ______________________________

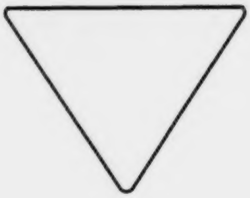
11. Identify the following shapes of traffic signs.



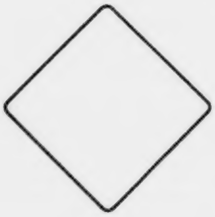
a. ______________



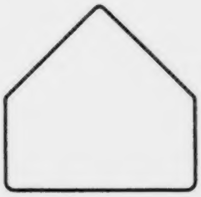
b. ______________



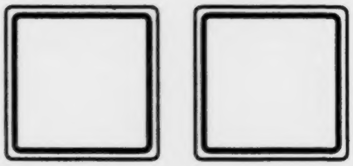
c. ______________



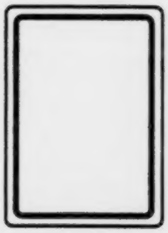
d. ______________



e. ______________



f. ______________



g. ______________

TEST

12. Select from the following list the general safety precautions to observe when operating equipment by placing an "X" in the blanks provided.

_____a. Tie back long hair

_____b. Ground equipment when working near energized line

_____c. Be sure outriggers or stabilizers are on solid footing

_____d. Overload only heavy equipment

_____e. Do not let anyone stand under load or boom

_____f. Do not wear jewelry

_____g. Make sure everyone is clear before extending outriggers or stabilizers

_____h. Do not put side strain on rotating boom

_____i. Do not overload equipment

_____j. Operate only the equipment you are trained and authorized to use

13. State OSHA/DOT regulations for inspection of equipment.

____

____

____

____

____

14, Select from the following list the items which should be inspected daily on mechanical equipment. Place an "X" in the blanks provided.

a. Vehicles

_____ 1) Service brake including trailer brake connections

_____ 2) Parking (hand) brake

_____ 3) Transmission

_____ 4) Steering mechanism

_____ 5) Lighting devices and reflectors

May be photocopied for student use.

TEST

_____ 6) Tires
_____ 7) Horn
_____ 8) Windshield wipers
_____ 9) Rear vision mirrors
_____10) Radiator
_____11) Coupling devices
_____12) Wheels and rims
_____13) Fire extinguisher
_____14) First aid kit
_____15) Personal protective equipment
_____16) Emergency equipment

b. Rotating-lifting equipment

_____ 1) Hydraulic system filters
_____ 2) Coolant level
_____ 3) Hydraulic hoses
_____ 4) Hydraulic cylinders
_____ 5) Cylinder attachment points
_____ 6) Boom
_____ 7) Proper marking of controls and decals
_____ 8) Electrical connections
_____ 9) Dielectric oil
_____10) Capacity chart for boom
_____11) Hydraulic/Pneumatic tools

TEST

15. List three methods for maintaining a clean and orderly work area.

a. ______________________________

b. ______________________________

c. ______________________________

16. Explain how to lift heavy objects.

____

____

____

17. Describe in a short paragraph the importance of safety communications.

____

____

____

18. Select from the following list the items that should be reported to the supervisor. Place an "X" in the blanks provided.

_____a. Unsafe tools

_____b. All accidents

_____c. Unsafe conditions

_____d. Unsafe acts

_____e. Kinds of equipment

_____f. Change of location

_____g. Unsafe equipment

_____h. Job location

TEST

19. Select from the list below items related to safety that a line technician should know concerning location and voltage. Place an "X" in the blanks provided.

a. Location

_____ 1) Circuit breakers

_____ 2) Regulators

_____ 3) Capacitor stations

_____ 4) Multi-feed transformer banks

_____ 5) Private generators

_____ 6) Phase transpositions

_____ 7) Underground feeders

_____ 8) Pole yard

_____ 9) Transformer banks

_____10) Other suppliers' lines

_____11) Lines paralleled with other suppliers' lines

_____12) Substations

_____13) Loop feeds

_____14) Identify, mark, or label proper locations

b. Voltage

_____ 1) Transformers (primary and secondary)

_____ 2) Loading coils

_____ 3) Distribution lines

_____ 4) Metering equipment

_____ 5) Service lines

_____ 6) Transmission lines

_____ 7) Secondary lines

TEST

20. State the five factors which determine the maximum weight which can be lifted by equipment.

    a. ____________________

    b. ____________________

    c. ____________________

    d. ____________________

    e. ____________________

21. Evaluated on Assignment Sheet 1.

22. Evaluated on Assignment Sheet 2.

COMMUNICATIONS
UNIT 2

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

   - Provide student with objectives sheet.
   - Provide student with information sheet.
   - Discuss unit and specific objectives.
   - Discuss information sheet.
   - Have student practice hand signals.
   - Have student role play using the radio.
   - Give test.

2. Unit references:

   - *Oklahoma City Cellular Mobile Telephone Service Customer Handbook.* Southwestern Bell Mobile Systems.
   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

COMMUNICATIONS
UNIT 2

ANSWERS TO TEST

1. a. Verbal
   b. Hand signals
   c. Radio
   d. Cellular mobile telephones
   e. Written
2. a. 1, 3
   b. 1, 2
   c. 1, 2, 3
3. (NOTE: Any four of the following are acceptable.)
   a. Worker's responsibility
   b. Supervisor's responsibility
   c. Worker's authority
   d. Supervisor's authority
   e. Unsafe conditions of tools and equipment
   f. Unsafe acts
   g. All accidents
4. a, b, c
5. a. Stop
   b. Lower the load
   c. Raise the load
   d. Emergency stop

ANSWERS TO TEST

6. a. Pull
   b. Lower
   c. Slack off slowly or lower a little
   d. Hoist
   e. Take up slowly or raise a little
7. a. Crowd or extend
   b. Raise boom, lower load
   c. Raise boom
   d. Lower boom
   e. Lower boom, raise load
   f. Rehaul or retract
   g. Raise boom, hold load
   h. Lower boom, hold load
   i. Raise boom slowly
   j. Lower boom slowly
   k. Swing in direction finger points
8. a. Move
   b. Turn while moving
   c. Straighten out
9. a. All off
   b. Stop
   c. Pull up wire
   d. Slack back
10. a, b, d, e, f, h

ANSWERS TO TEST

11. a. Have necessary information ready

    1) Location

    2) Type of accident or emergency

    3) Type of assistance needed

    b. Call dispatcher and give information

    c. Wait for verification

12. a, b, c, d, f, g, h, i, j

13.

a.	4	i.	15	q.	21	y.	11
b.	1	j.	13	r.	22	z.	14
c.	5	k.	18	s.	26	aa.	28
d.	2	l.	6	t.	20	bb.	29
e.	3	m.	23	u.	7	cc.	32
f.	8	n.	16	v.	24	dd.	27
g.	10	o.	19	w.	9	ee.	31
h.	17	p.	25	x.	12	ff.	30

14. a. Placing a call

    b. Receiving a call

    c. Limitations

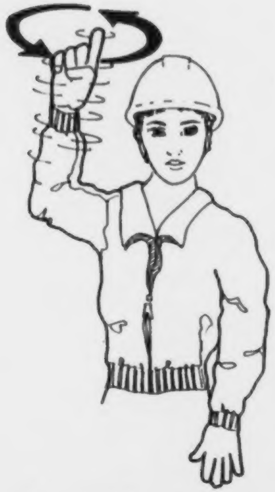
    d. Power sources

    e. Directory assistance

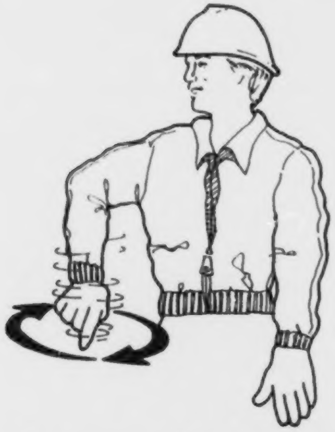
    f. FCC rules and regulations

    g. Emergency procedures

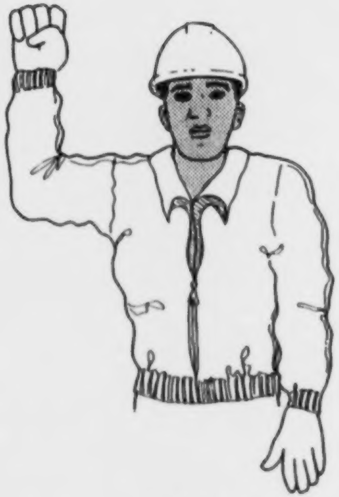
Hoist Signals



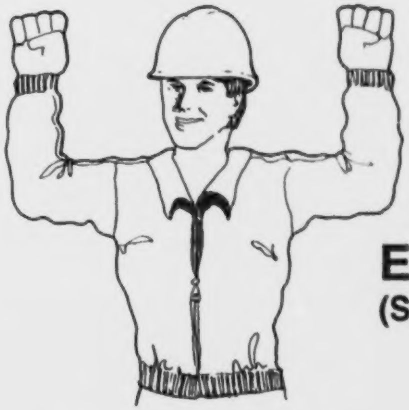
Raise the load



Lower the load



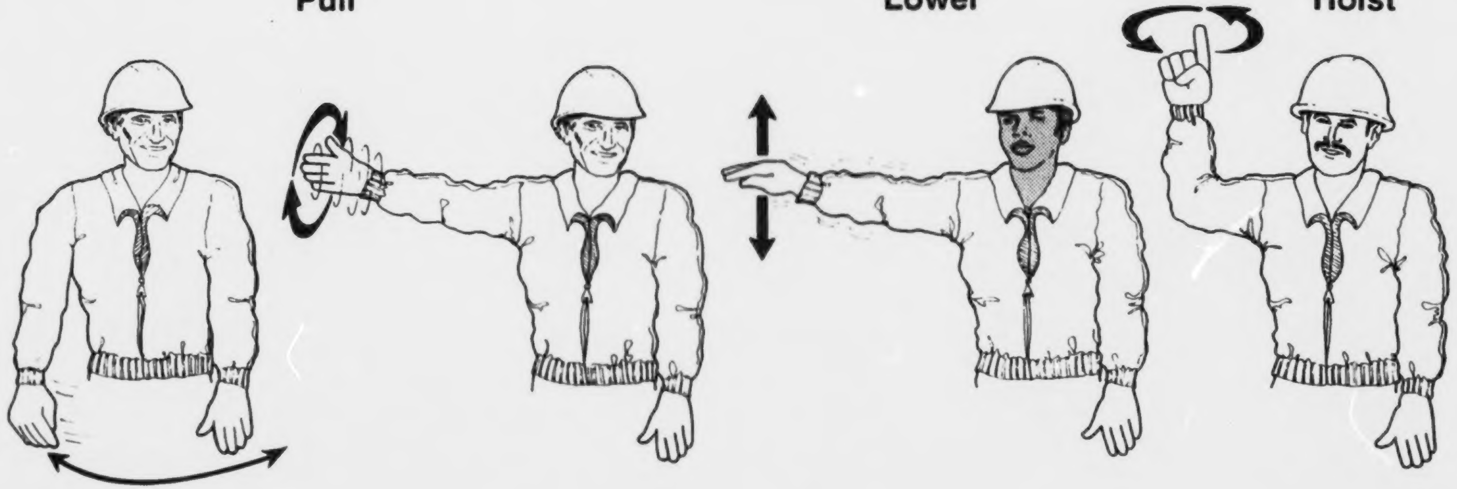
Stop



Emergency stop
(Stop all motion as quickly as possible)

May be photocopied for student use.

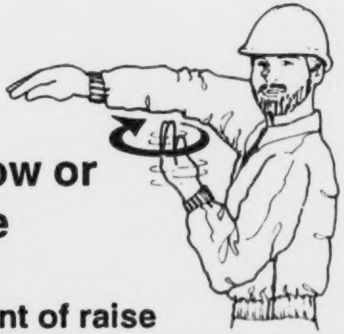
Winch Line



Pull

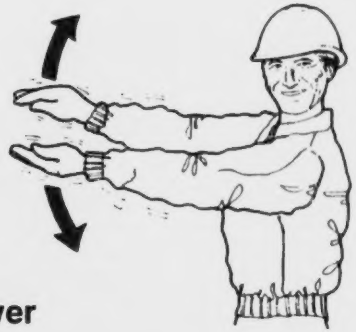
Lower

Hoist



Take up slow or raise a little

Indicate amount of raise by spread of hands

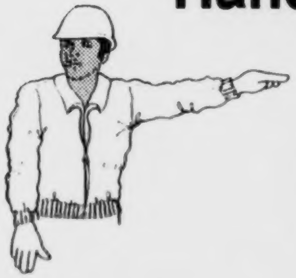


Slack off slow or lower a little

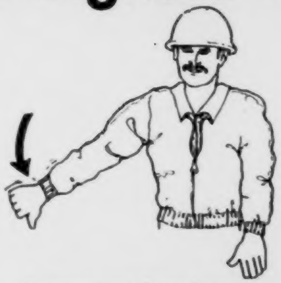
Indicate amount of lower by spread of hands

May be photocopied for student use.

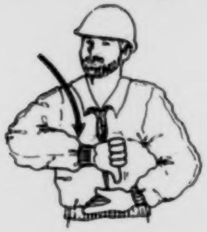
Hand Signals for Boom Operation



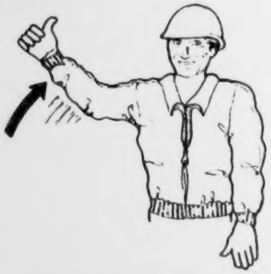
Swing in direction finger points



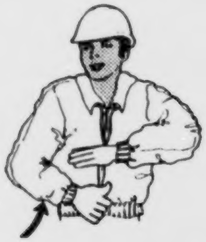
Lower the boom



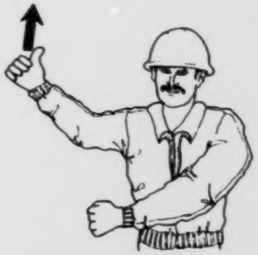
Lower the boom slowly



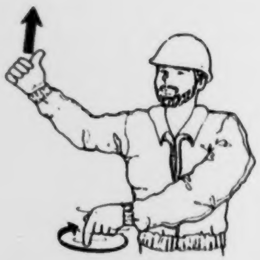
Raise the boom



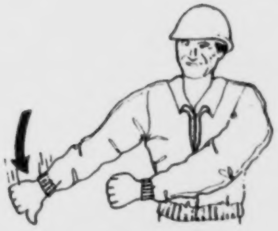
Raise the boom slowly



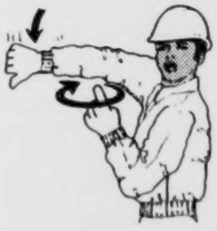
Raise the boom and hold the load



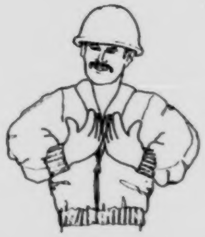
Raise the boom and lower the load



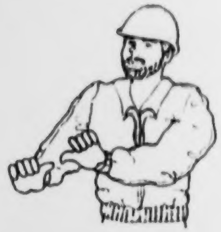
Lower the boom and hold the load



Lower the boom and raise the load



Crowd or extend



Rehaul or retract

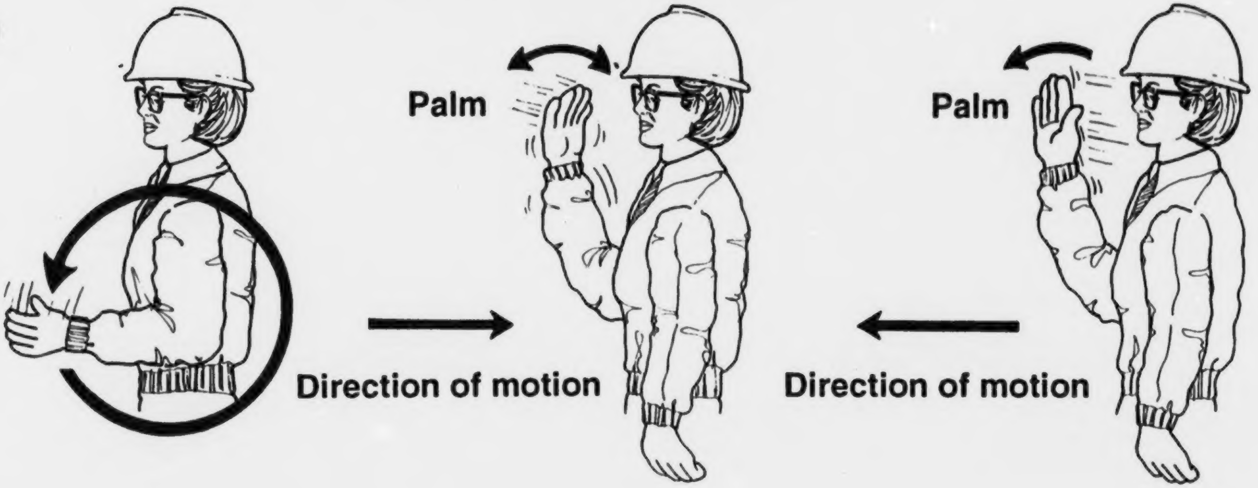
May be photocopied for student use.

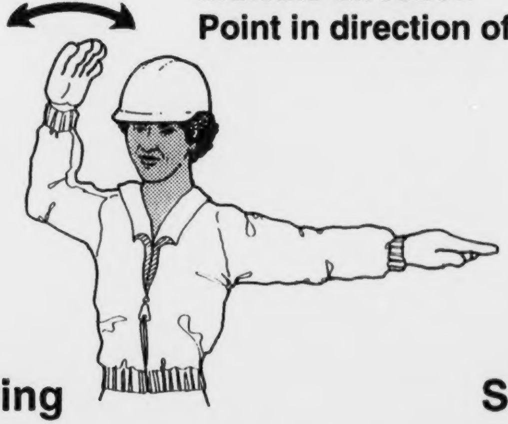
TM 3

PLT B - 2 - 11

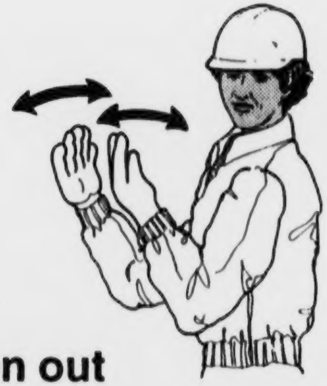
Maneuvering Vehicle

Move


Palm
Palm
Direction of motion
Direction of motion

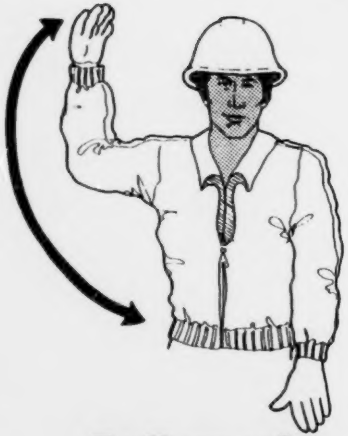

Indicate direction
Point in direction of turn

Turn while moving



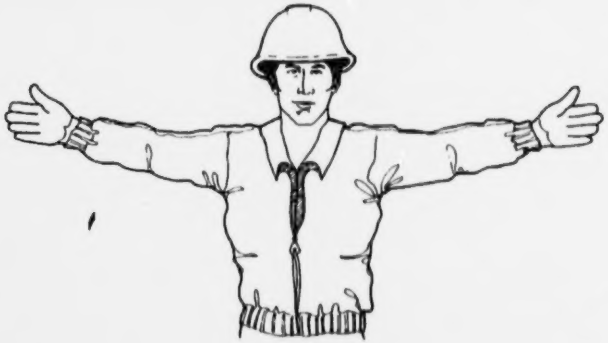
Straighten out

Standard Signals for Linework



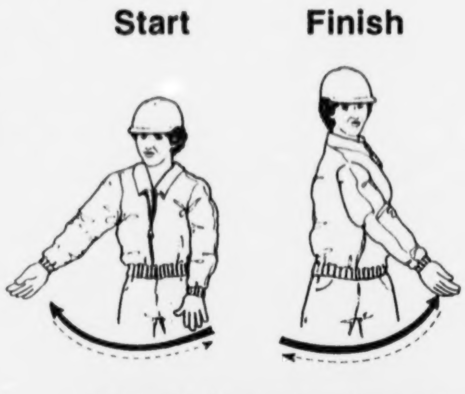
Pull up wire

Indicated by arm up, bent at elbow, and swinging down to side



Stop

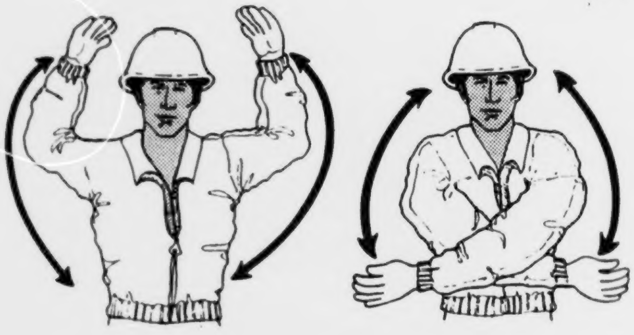
Indicated by both arms out horizontal



Slack back signal

Indicated by arm down, body stooping over sideways, arm swinging from side to side

All off signal



Indicated by arms crossed and over head

and

Swinging down to a crossed position below waist

COMMUNICATIONS
UNIT 2

TEST

NAME ______________________________ SCORE __________

1. List five types of necessary communications for an REC employee.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

2. Select from the following list the items of communication that are important between fellow workers.

   a. Pole buddy or other crew members

      _____1) What you are doing

      _____2) When lunch time is

      _____3) What your buddy's position is in relation to energized conductors or unsafe conditions

   b. Other crews

      _____1) Where are you

      _____2) What you are doing

      _____3) What time it is

   c. Radio dispatcher

      _____1) When you are going to be away from your radio

      _____2) When you arrive at a job site

      _____3) When you leave a job site

      _____4) When you leave on vacation

TEST

3. List four items of communication that are important between the worker and the supervisor.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

4. Select from the following list those items of communication that are important between the worker and the general public.

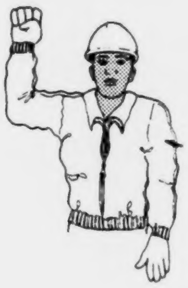
   _____a. Programs of your organization

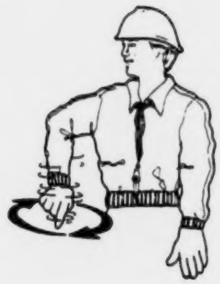
   _____b. Hazards to the public at job site

   _____c. Purpose of your organization

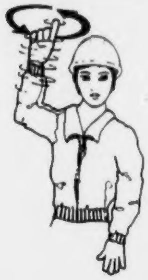
   _____d. Responsibilities or your job

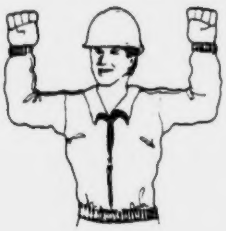
5. Identify the following hoist signals





a. ____________________ b. ____________________

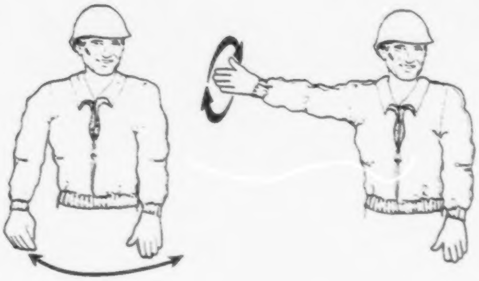


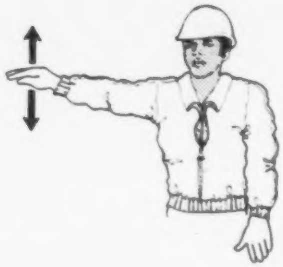


c. ____________________ d. ____________________

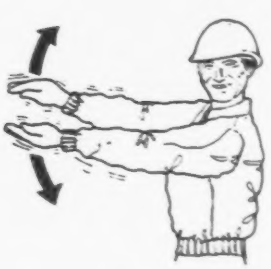
TEST

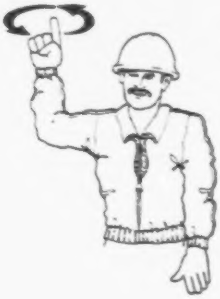
6. Identify the following winch line signals.

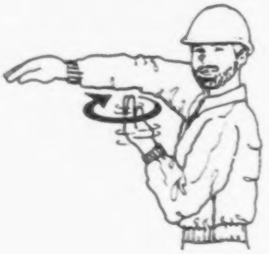




a. ____________________ b. ____________________

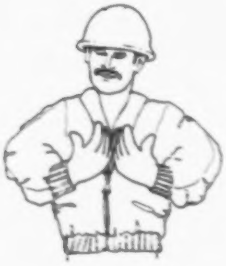


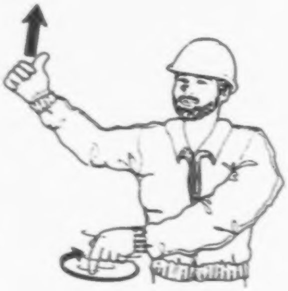


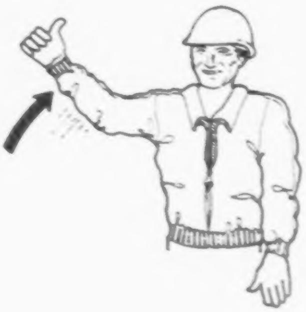


c. ____________________ d. ____________________ e. ____________________

7. Identify the following hand signals used in boom operations.



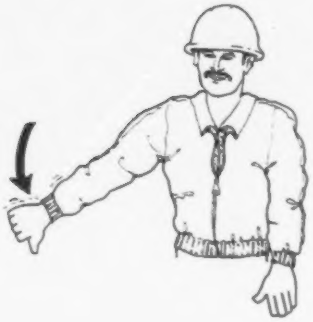




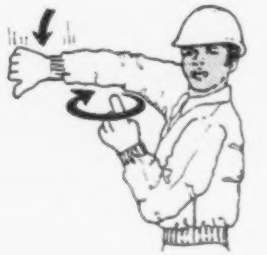
a. ____________________ b. ____________________ c. ____________________

May be photocopied for student use.

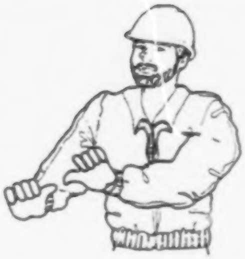
TEST



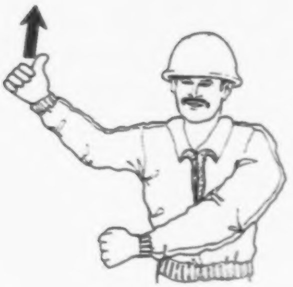
d. ____________________



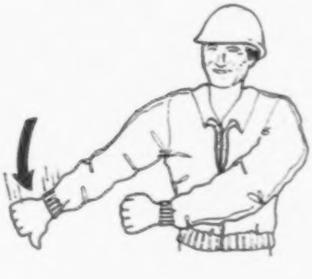
e. ____________________



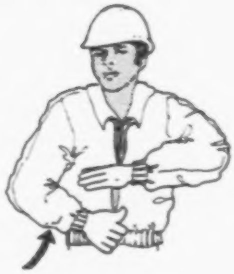
f. ____________________



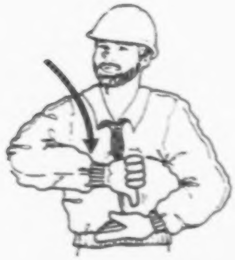
g. ____________________



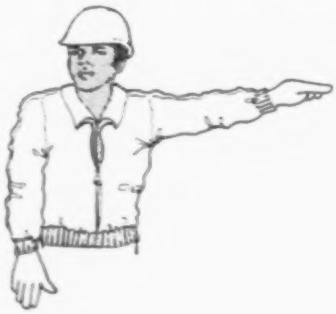
h. ____________________



i. ____________________



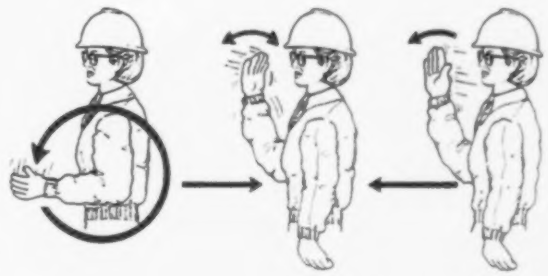
j. ____________________



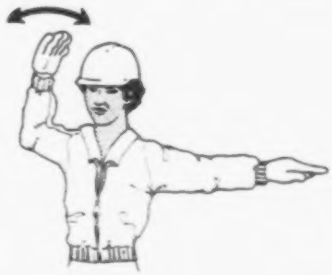
k. ____________________

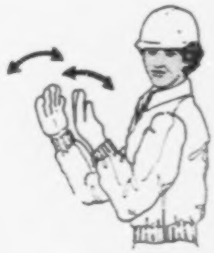
TEST

8. Identify the following hand signals used when maneuvering vehicles.



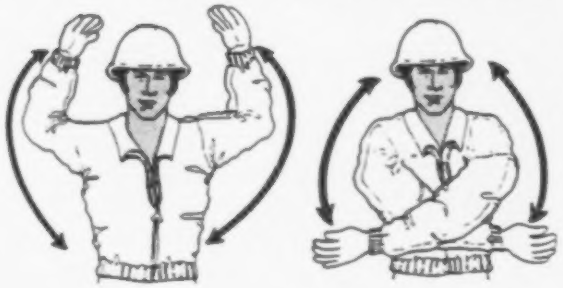
a. ____________________

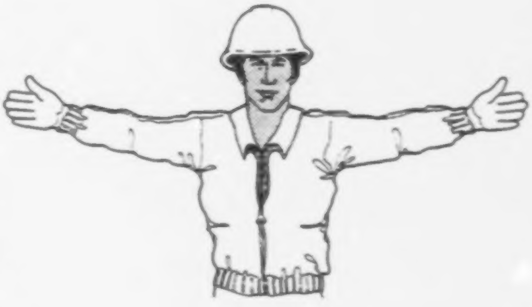




b. ____________________ c. ____________________

9. Identify the following linework signals.

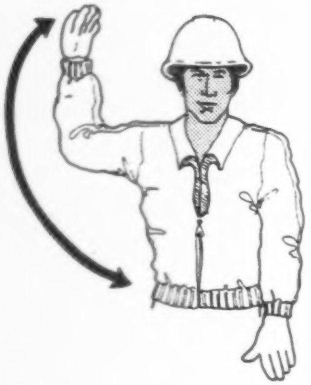




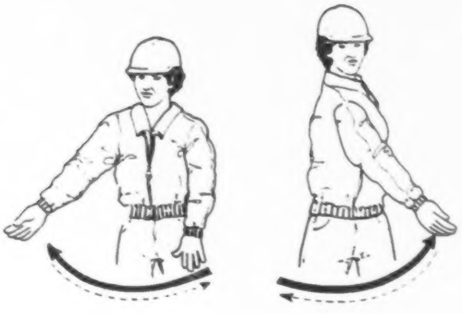
a. ____________________ b. ____________________

May be photocopied for student use.

TEST



c. ____________________



d. ____________________

10. Select from the following list the proper radio procedures.

_____a. Keep message as brief and precise as possible

_____b. Call the base station by giving your unit number and the call letters of the base station

_____c. Hold microphone twelve to eighteen inches from mouth

_____d. Give your call letters and unit number and the unit number you are calling

_____e. Clear the air when message is complete by giving unit call letters and unit number

_____f. Speak clearly in normal voice tone and volume

_____g. Receive calls from other units or the base station by giving your unit number

_____h. Hold microphone three to four inches from mouth

11. State emergency radio procedure

a. ____

b. ____

c. ____

TEST

12. Select from the following list the prohibited uses of the radio.

_____a. Selling something

_____b. Interference with other communications

_____c. Unnecessary or personal conversations

_____d. Calls to or conversations with stations other than your own

_____e. Routine business messages

_____f. Music or sound effects

_____g. Obscene, profane, or indecent language

_____h. Messages not directed to any one person

_____i. Using messages with special meanings

_____j. Relaying messages for someone other than your system units except in an emergency

13. Match the code numbers on the right to the correct meanings.

_____a. Caution

_____b. Unable to copy; change location

_____c. Signal good

_____d. Acknowledgement

_____e. Relay

_____f. Busy; stand by unless urgent

_____g. Out of service (give location and/or telephone number)

_____h. In service

_____i. Repeat

_____j. Stand by (stop)

_____k. Location

_____l. Call...by telephone

1. 10-1
2. 10-4
3. 10-5
4. 10-0
5. 10-2
6. 10-21
7. 10-52
8. 10-6
9. 10-68
10. 10-7
11. 10-74
12. 10-69

TEST

_____m. Disregard
_____n. Arrived at scene
_____o. Assignment completed
_____p. Report in person to (meet)...
_____q. Illegal use of radio
_____r. Beginning tour of duty
_____s. Ending tour of duty
_____t. Wrecker needed
_____u. Ambulance needed
_____v. Message cancellation
_____w. Dispatch information
_____x. Message received
_____y. Negative
_____z. In contact with
_____aa. En route
_____bb. ETA (estimated time of arrival)
_____cc. Need assistance
_____dd. If meeting...advise ETA
_____ee. Check (test signal)
_____ff. Emergency situation

13. 10-12
14. 10-75
15. 10-9
16. 10-23
17. 10-8
18. 10-20
19. 10-24
20. 10-51
21. 10-30
22. 10-41
23. 10-22
24. 10-66
25. 10-25
26. 10-42
27. 10-84
28. 10-76
29. 10-77
30. 10-33
31. 10-97
32. 10-78

TEST

14. List factors that are important when using cellular mobile telephones.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

BASIC ELECTRICAL THEORY
UNIT 3

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:
    - Provide student with objective sheet.
    - Provide student with information and assignment sheets.
    - Make transparencies.
    - Discuss unit and specific objectives
    - Discuss information and assignment sheets.
    - Work problems using Ohm's law.
    - Show student charts, films, and other supplemental material on electrical theory.
    - Give test.
2. Unit references:
    - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

BASIC ELECTRICAL THEORY
UNIT 3

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

1. 120
2. 480
3. 240
4. 1200
5. 14,400

Assignment Sheet 2

1. 36
2. 10
3. 20
4. 120
5. 7.5
6. 20
7. 13
8. 5
9. 2
10. .05

Assignment Sheet 3

1. 360
2. 12
3. 150
4. 1200
5. 40

BASIC ELECTRICAL THEORY
UNIT 3

ANSWERS TO TEST

1.

a.	12	g.	7	m.	2	s.	23
b.	14	h.	8	n.	3	t.	19
c.	13	i.	5	o.	6	u.	22
d.	15	j.	10	p.	16	v.	17
e.	9	k.	11	q.	21	w.	18
f.	4	l.	1	r.	20	x.	24

2. (NOTE: Any four of the following are acceptable.)
   a. Light
   b. Heat
   c. Cooling
   d. Power
   e. Communications
   f. Control

3. a. All things are made of atoms
   b. Atoms contain protons and electrons
      1) Nucleus is made up of one or more protons
      2) Electrons orbit the nucleus
   c. Electrons in outer orbit of atoms may move from one atom to another
   d. Voltage applied to a conductor causes electrons to move in a closed circuit
   e. Electron movement in a conductor is current flow

4.

a.	D	c.	A	e.	A
b.	A	d.	D		

ANSWERS TO TEST

5. a. 1
   b. 3
   c. 2

6. Unlike poles attract; like poles repel

7. a. Surrounds a magnet
   b. Flows from north pole to south pole
   c. Generates electricity when a bar magnet is moved in and out of a coil of wire
   d. Produces electricity when a conductor cuts the lines of magnetic force

8. a, b, d

9. a. Occurs when a magnet is moved close to a coil
   b. Occurs when a coil is moved close to a magnet
   c. Occurs when a strong bar magnet is moved in and out of a coil

10. a. Voltage will be induced in a conductor that moves across an electromagnetic field
    b. Voltage will be induced in a coil when changing current is applied to an adjacent coil

11. a. Parallel circuit
    b. Series-parallel circuit
    c. Series circuit

12. a. Open circuit
    b. Closed circuit
    c. Shorted circuit

13. a. Alternating current
       1) Generators
       2) Alternators

ANSWERS TO TEST

b. Direct current

(NOTE: Any two of the following are acceptable.)

1) Generators
2) Batteries
3) Solar cells

14. a. Generation plant
    b. Transmission lines
    c. Transformer
    d. Distribution lines
    e. Secondary lines
    f. Distribution transformer
    g. Service lines
    h. Meter pole
    i. Substation

15. One volt will push one ampere through one ohm of resistance

16. a. $E = 120$
    b. $I = 10$
    c. $I = 12$
    d. $R = 48$

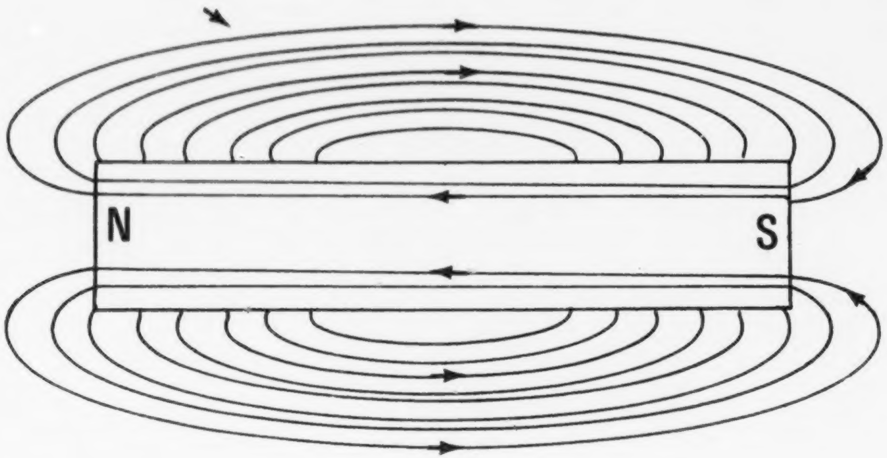
17. Evaluated on Assignment Sheet 1.

18. Evaluated on Assignment Sheet 2.

19. Evaluated on Assignment Sheet 3.

Magnetic Force

Lines of force



The lines of force move from the south pole to

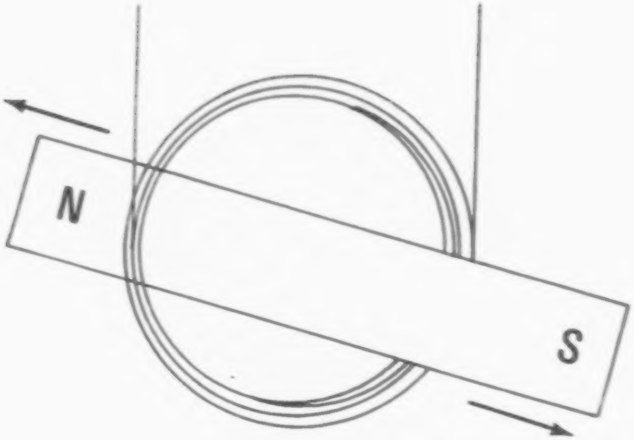
the north pole through the magnet

May be photocopied for student use.

81

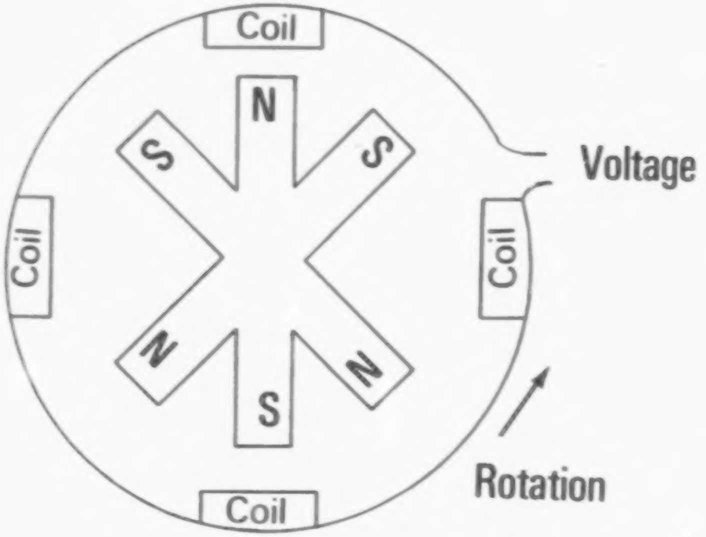
82

Generation of Electricity



As magnet moves in and out of coil,

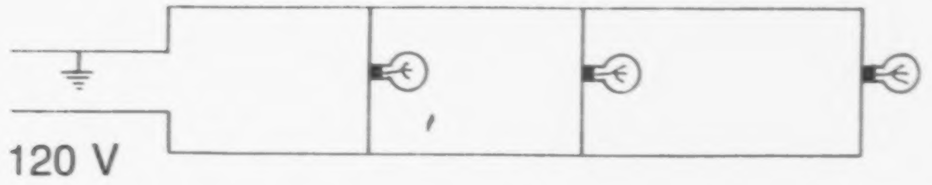
voltage is created in coil.


Coil
N
S
S
Voltage
Coil
Coil
N
N
S
Rotation
Coil

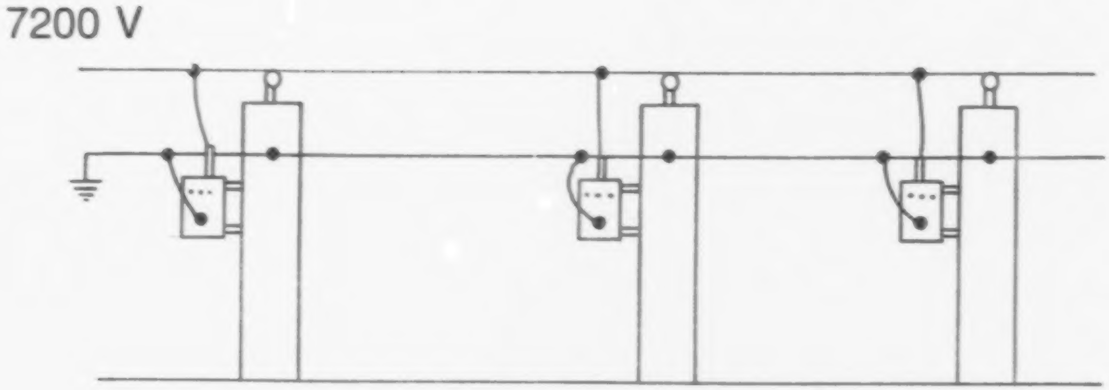
SIMPLE GENERATOR

Types of Circuits

PARALLEL CIRCUITS



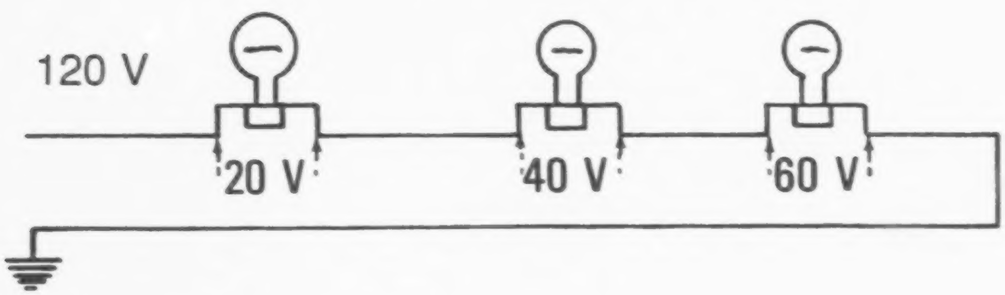
LOW VOLTAGE

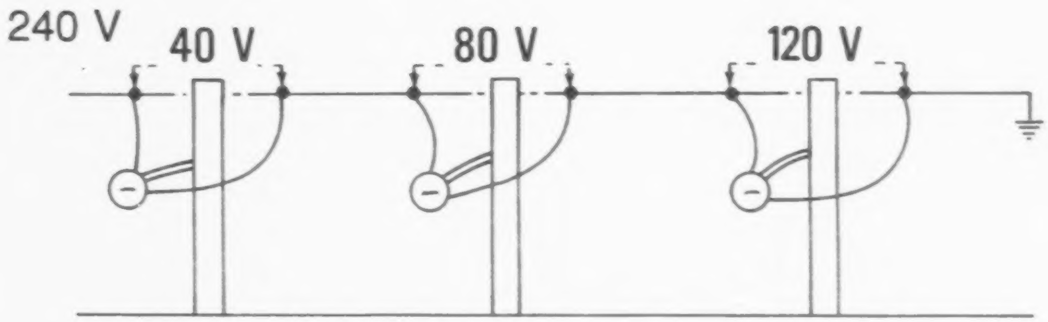


HIGH VOLTAGE

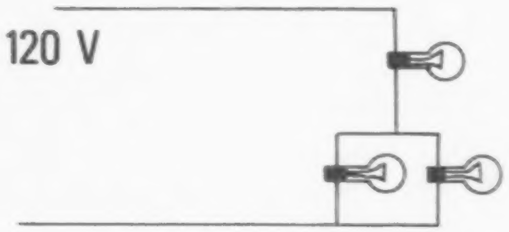
Types of Circuits
(Continued)

SERIES CIRCUITS

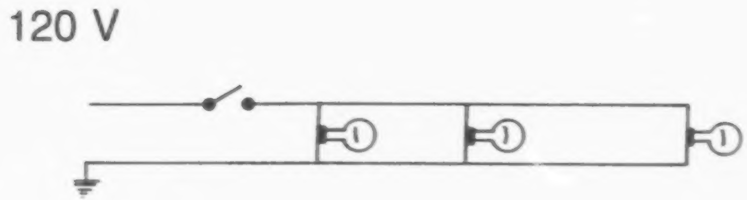

120 V
20 V
40 V
60 V


240 V
40 V
80 V
120 V

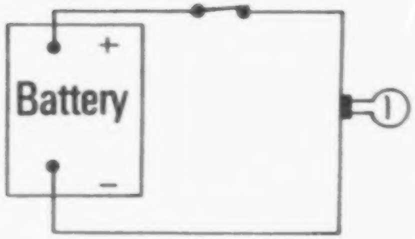
SERIES-PARALLEL CIRCUIT



Conditions of Circuits

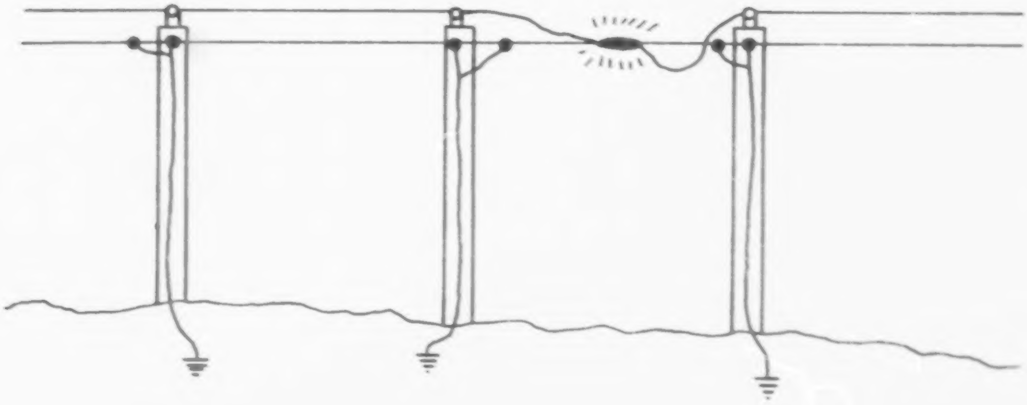


OPEN CIRCUIT

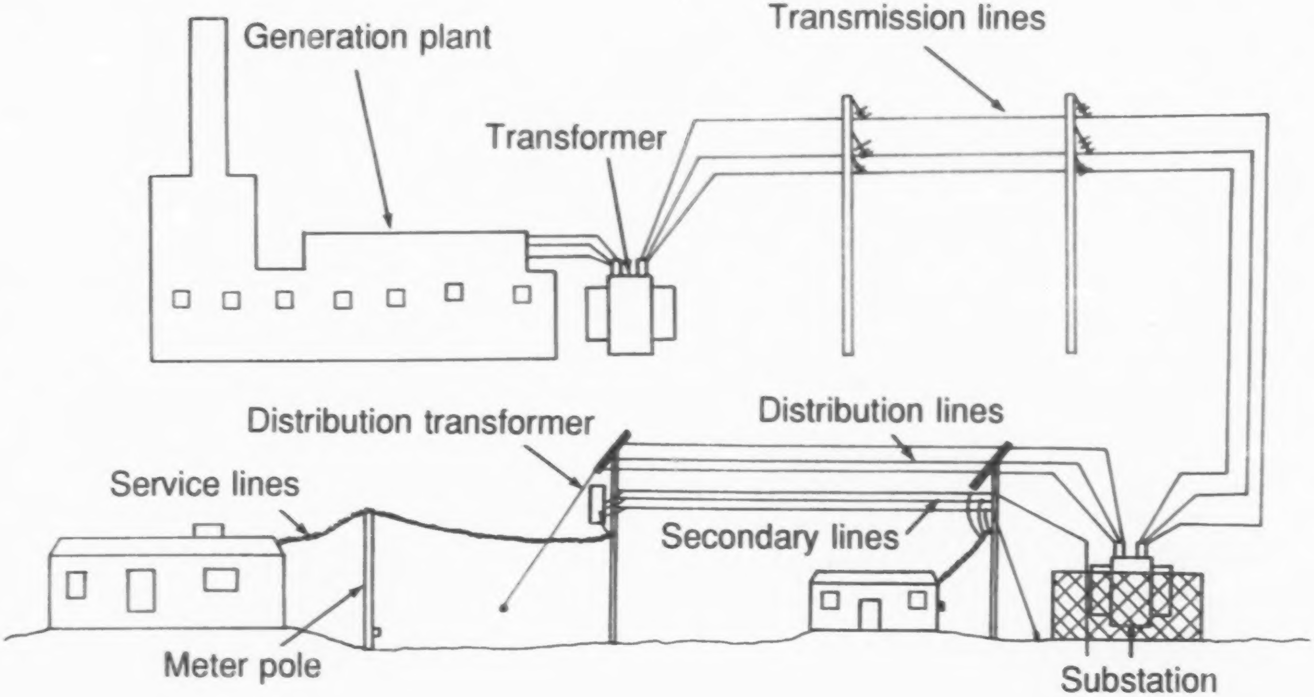


CLOSED CIRCUIT

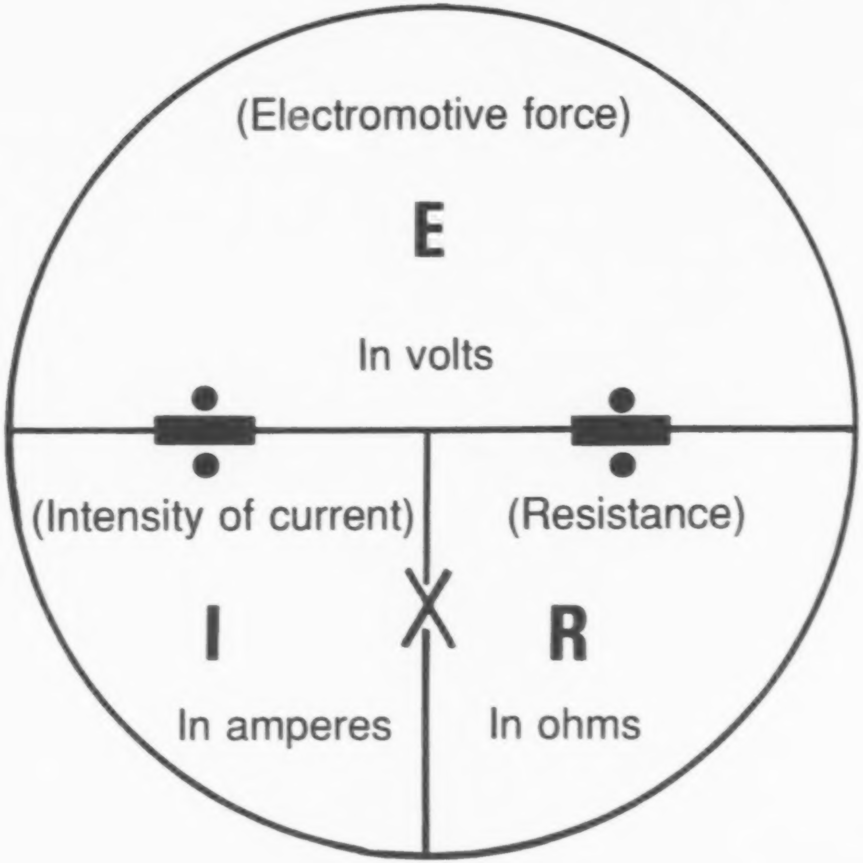
SHORTED CIRCUIT



Divisions of Electrical System


Generation plant
Transmission lines
Transformer
Distribution transformer
Distribution lines
Service lines
Secondary lines
Meter pole
Substation

Ohm's Law



(Electromotive force)

E

In volts

(Intensity of current)

I

In amperes

(Resistance)

R

In ohms

BASIC ELECTRICAL THEORY
UNIT 3

TEST

NAME ____ SCORE ____________

1. Match the terms on the right to the correct definitions.

_____a. Energy that can easily be converted into light, heat, and power

_____b. Unit of measure used to determine current flow through a conductor

_____c. Unit of measure of electromotive force

_____d. Unit of measure used to determine the rate of energy supplied

_____e. One watt for one hour

_____f. 1000 watts

_____g. 1,000,000 watts

_____h. 1000 watts for 1 hour

_____i. Unit of mechanical power equal to 746 watts of electrical power

_____j. Current that flows in one direction at a continuous rate

_____k. Current that reverses flow from positive to negative and back to positive at regular intervals

_____l. Path through which electricity flows

_____m. Device used to open or close a circuit

_____n. Device used to open a circuit when current flow is too great

_____o. Device used to open a circuit by burning out when current flow becomes too great

1. Circuit
2. Switch
3. Circuit breaker
4. Kilowatt (kW)
5. Horsepower
6. Fuse
7. Megawatt (MW)
8. Kilowatt-hour
9. Watt-hour
10. Direct current (DC)
11. Alternating current (AC)
12. Electricity
13. Volt
14. Ampere
15. Watt

TEST

_____p. Any substance through which electrical current can flow easily

_____q. Any substance which will not allow the flow of electrical current in any measurable amount

_____r. Slang for an electrically energized conductor

_____s. Presence of voltage in a conductor

_____t. Current-carrying conductor that is connected to a ground

_____u. Current-carrying conductor which may or may not be grounded

_____v. Unit of frequency; one complete reversal of alternating current from positive to negative and back to positive

_____w. Point of connection of a conductor to assist returning current flow to return to the source or to equalize potential

_____x. 1,000,000,000 watts

16. Conductor
17. Hertz
18. Ground
19. Neutral
20. Hot wire
21. Insulation
22. Common
23. Potential
24. Gigawatt (GW)

2. List four uses of electricity.

a. ____

b. ____

c. ____

d. ____

3. Discuss the electron theory.

____

____

____

____

____

TEST

4. Distinguish between types of current by placing an "A" in front of characteristics of alternating current and a "D" in front of direct current.

_____a. Flows in one direction only

_____b. Transforms easily to higher or lower voltage

_____c. Reverses direction of flow at regular intervals

_____d. Does not transform easily

_____e. Produces an alternating magnetic field

5. Match the types of magnets on the right to the correct descriptions.

_____a. Lodestone

_____b. Magnet made with a coil of copper wire

_____c. Magnet made of iron, nickel, cobalt, or other metals

1. Natural

2. Artificial

3. Electromagnet

6. State the law of magnetic poles.

7. Describe magnetic force as it relates to production of electricity.

8. Select from the list characteristics of electromagnetic force by placing an "X" in the blanks.

_____a. A magnetic field is created around a current-carrying conductor

_____b. Electromagnetic force increases as current flow increases

_____c. Electromagnetic force is found only in a lodestone

_____d. An iron or steel core inside an energized coil will increase the electromagnetic force by concentrating the lines of force

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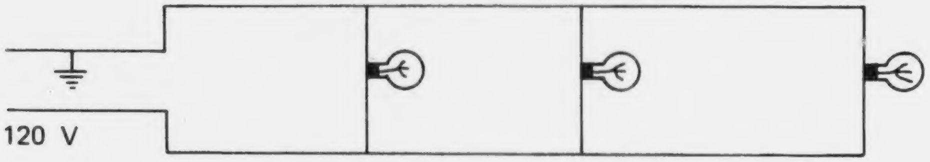
TEST

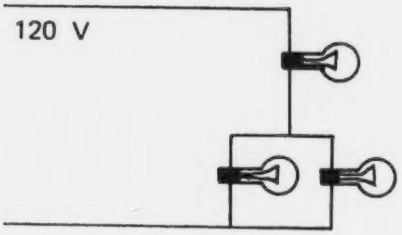
9. Explain the generation of electricity using magnets.

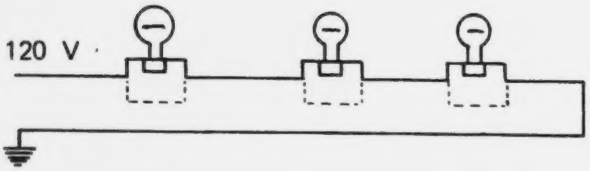
10. Describe electromagnetic induction.

11. Identify the following types of circuits.



a. ____________



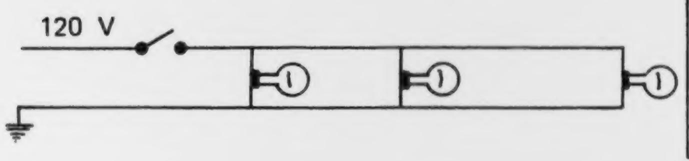


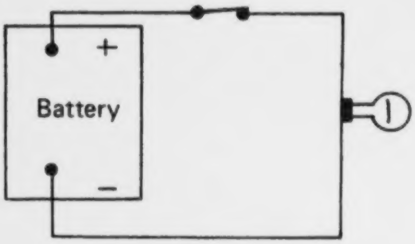
b. ____________

c. ____________

TEST

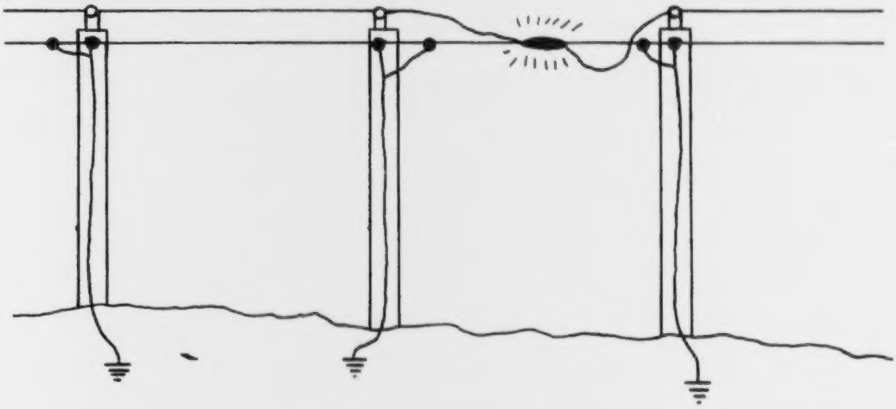
12. Identify the following conditions of circuits.





a. ________________

b. ________________



c. ________________

13. Name two sources of alternating current and two sources of direct current.

a. Alternating current

1) ____

2) ____

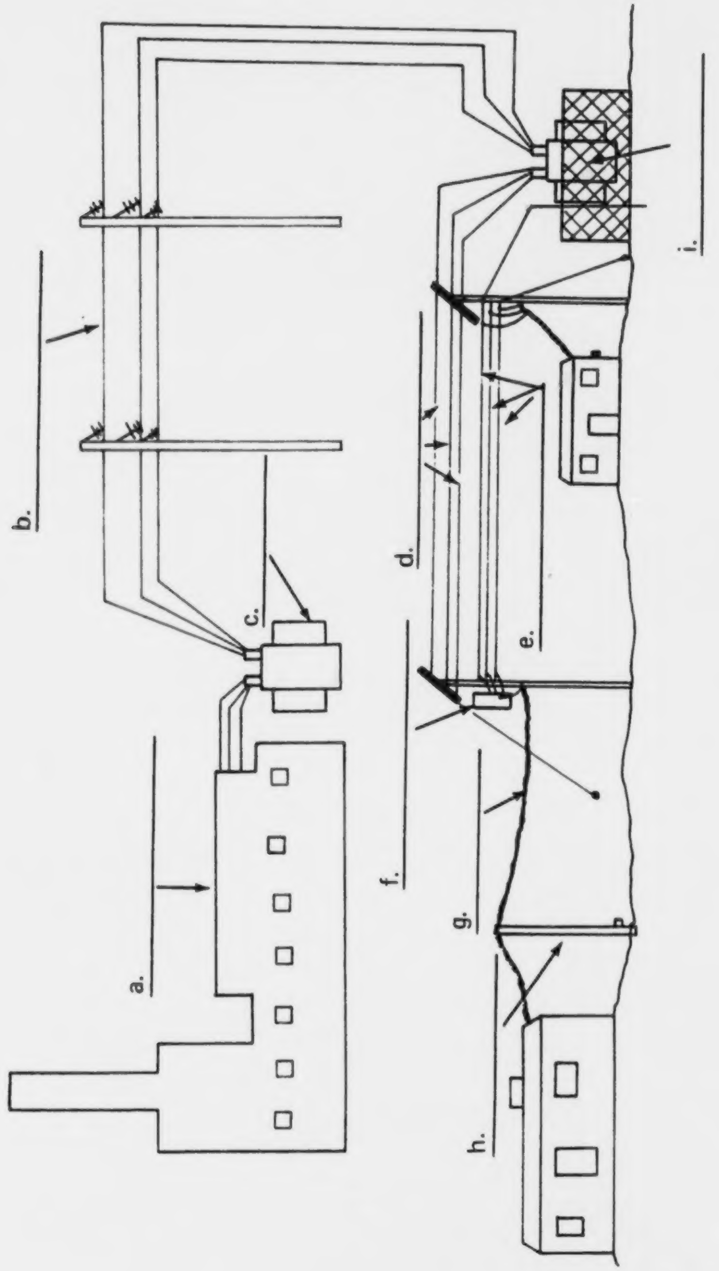
b. Direct current

1) ____

2) ____

TEST

14. Identify the divisions of the electrical system below by filling in the blanks.



May be photocopied for student u[illegible].

TEST

15. State the relationship among amperage, resistance, and voltage.

____

____

16. Solve the following problems using Ohm's law.

    a. Find the voltage when:
    $I = 5$ and $R = 24$ $E =$ ________________

    b. Find the amperage when:
    $E = 240$ and $R = 24$ $I =$ ________________

    c. Find the amperage when:
    $P = 2880$ and $E = 240$ $I =$ ________________

    d. Find the resistance when:
    $E = 480$ and $I = 10$ $R =$ ________________

17. Evaluated on Assignment Sheet 1.

18. Evaluated on Assignment Sheet 2.

19. Evaluated on Assignment Sheet 3.

May be photocopied for student use.

ROPE AND RIGGING
UNIT 4

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:
   - Provide student with objective sheet.
   - Provide student with information and assignment sheets.
   - Make transparencies.
   - Discuss objective sheet.
   - Discuss information and assignment sheets.
   - Have students practice typing various knots and hitches.
   - Give test.
2. Unit references:
   - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook.* 7th ed. New York: McGraw-Hill Book Co., 1986.
   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

ROPE AND RIGGING
UNIT 4

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 1

Total sheaves = 6
Theoretical advantage = 6 to 1
Theoretical pull needed = 600 ÷ 6 = 100
Friction loss = 20% of 600 = 120
Weight to be lifted = 600 + 120 = 720
Actual pull needed = 720 ÷ = 120
Actual mechanical advantage = actual load (600) divided by actual pull needed (120) = 600 ÷
120 = 5

Actual mechanical advantage = 5 to 1

Assignment Sheet 2

1. 4500 ÷ 5 = 900
2. 36000 ÷ 5 = 7200
3. 4400 ÷ 5 = 880
4. 2650 ÷ 5 = 530

ROPE AND RIGGING
UNIT 4

ANSWERS TO TEST

1. a. 9
   b. 4
   c. 8
   d. 10
   e. 12
   f. 5
   g. 6
   h. 11
   i. 2
   j. 3
   k. 1
   l. 13
   m. 7
   n. 15
   o. 14

2. 1. Pin
   2. Thimble
   3. Shell
   4. Outer strap
   5. Hook
   6. Becket
   7. Inner strap
   8. Safety catch
   9. Sheaves

3. (NOTE: Any four of the following are acceptable.)
   a. Manila
   b. Nylon
   c. Dacron
   d. Polyethylene
   e. Polypropylene

ANSWERS TO TEST

4.

Diameter	Manila	Nylon	Dacron	Polyethylene	Polypropylene
3/16″	450	960	720	700	740
1/4″	600	1,500	1,150	1,200	1,250
5/16″	1,000	2,400	1,750	1,750	1,900
3/8″	1,350	3,400	2,450	2,500	2,700
7/16″	1,750	4,800	3,400	3,400	3,550
1/2″	2,650	6,200	4,400	4,100	4,500
9/16″	3,450	8,000	5,700	5,100	5,400
5/8″	4,400	10,000	7,300	6,000	6,600
3/4″	5,400	14,000	10,000	7,500	8,000
7/8″	7,700	19,000	13,600	9,900	10,750
1″	9,000	24,000	16,500	11,000	12,500
1 1/8″	12,000	31,500	21,600	15,000	17,000
1 1/4″	13,500	36,000	24,400	17,300	19,500

a. 1/4″ manila — 600

b. 1/4″ polyethylene — 1,200

c. 1 1/4″ nylon — 36,000

d. 3/4″ polypropylene — 8,000

e. 3/8″ dacron — 2,450

5. 5 sheaves = 5 to 1 theoretical mechanical advantage

500 ÷ 5 = 100 lbs theoretical pull needed

20% of 500 = 100 lbs
500 + 100 = 600 lbs
600 ÷ 5 = 120 lbs actual pull needed

500 ÷ 120 = 4.17
Actual mechanical advantage = 4 to 1

6. (NOTE: Any one from each group is acceptable.)

a. Block and tackle

1) Raising and lowering small transformers

2) Pulling wire

ANSWERS TO TEST

3) Lifting hot line tools

4) Lifting for general purposes

b. Sling

1) Lifting wire reels

2) Securing transformer to block and tackle

3) Securing conductor to pole

4) Lashing for general purposes

c. Hand line

1) Sending tools and small equipment to line mechanic on pole

2) Lowering tools and equipment from pole

3) Lowering line mechanic from pole in rescue situation

d. Tag line — Tying to insulating stick to hold conductor away from pole

7. a. Manila rope with 450 lbs tensile strength

Working load = 90 lbs

b. Nylon rope with 3400 lbs tensile strength

Working load = 680 lbs

c. Polyethylene rope with 2500 lbs tensile strength

Working load = 500 lbs

8. a. Running bowline

b. Half hitch

c. Square knot

d. Timber hitch

e. Timber hitch with half hitch

f. Slip knot

g. Bowline

h. Blackwall hitch

i. Sheepshank

ANSWERS TO TEST

9.

a.	4	d.	3	g.	5
b.	7	e.	2	h.	6
c.	9	f.	1	i.	8

10.

a.	Bight	e.	Whipping
b.	Overhand loop	f.	Round turn
c.	Underhand loop	g.	Turn
d.	Running end	h.	Standing part

11. (NOTE: Any four of the following are acceptable.)

    a. Improper knots or hitches

    b. Vehicles or foot traffic over rope

    c. Incorrect block and sheave size

    d. Overloading or sudden jerks

    e. Exposure to acid, fumes, or oil

    f. Dragging rope over sharp objects

    g. Permitting rope to freeze when wet

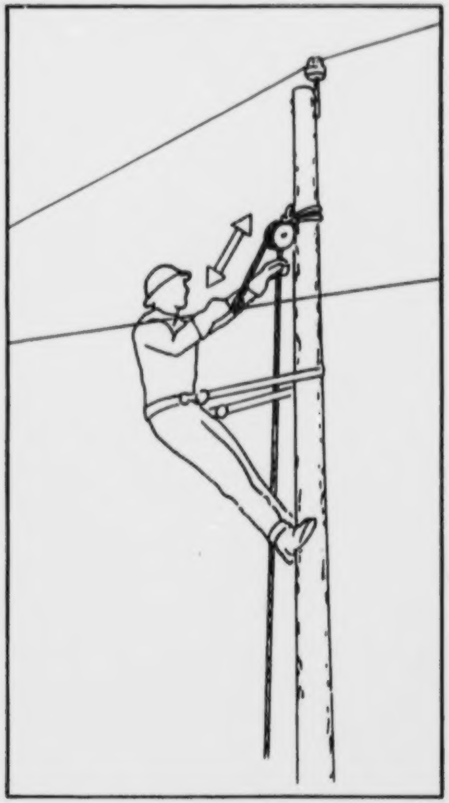
    h. Exposure to extreme heat

12. Evaluated on Assignment Sheet 1.

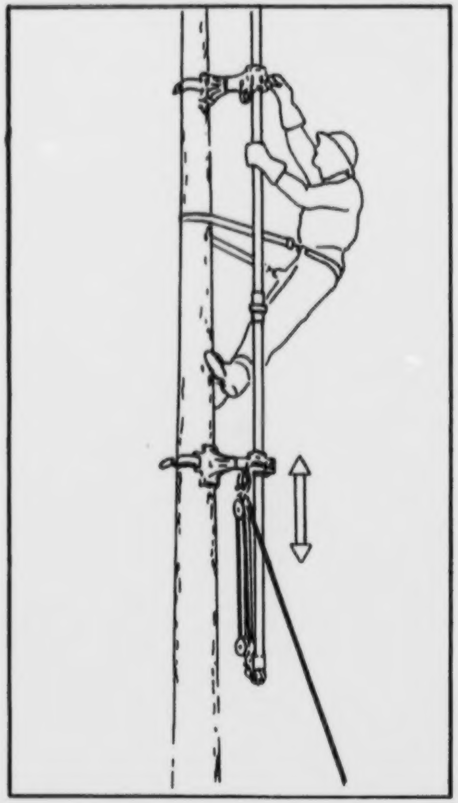
13. Evaluated on Assignment Sheet 2.

Uses of Rope Gear

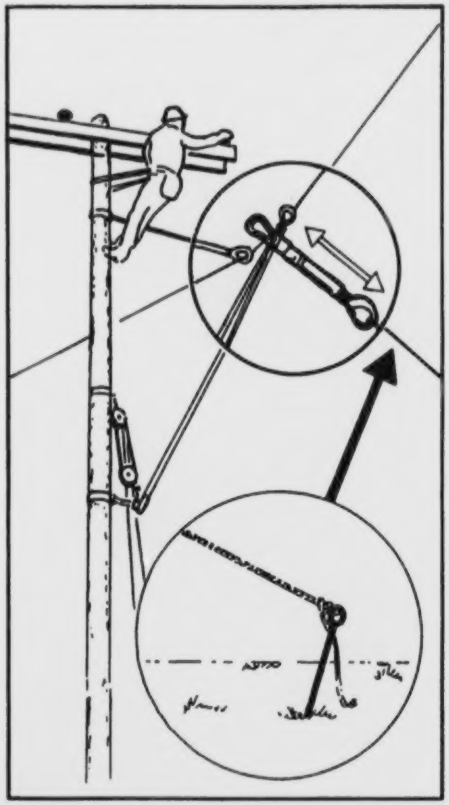
Hand Line



Block and Tackle



Tag Line



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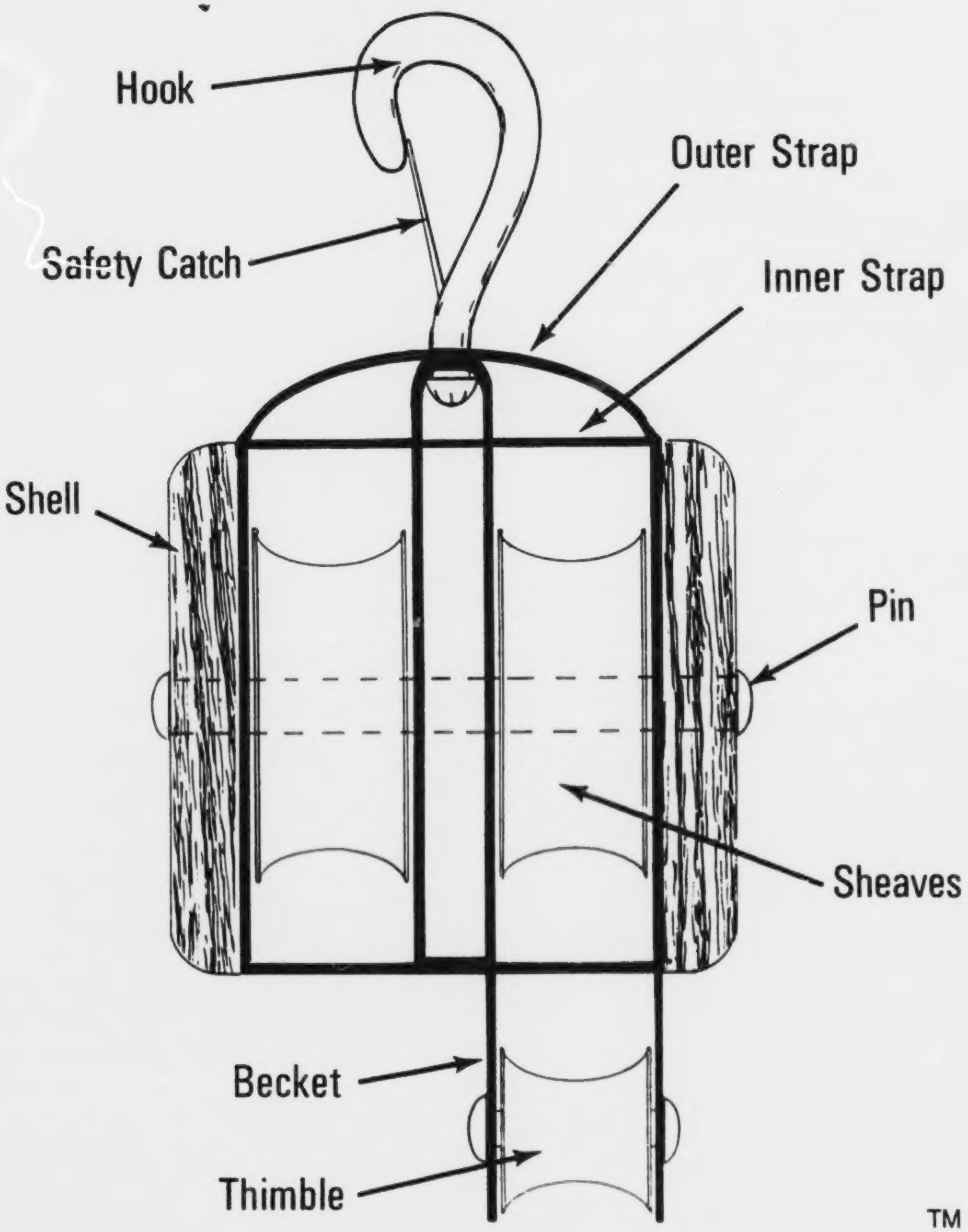
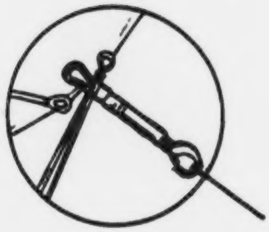
Parts of a Two Sheave Stationary Block

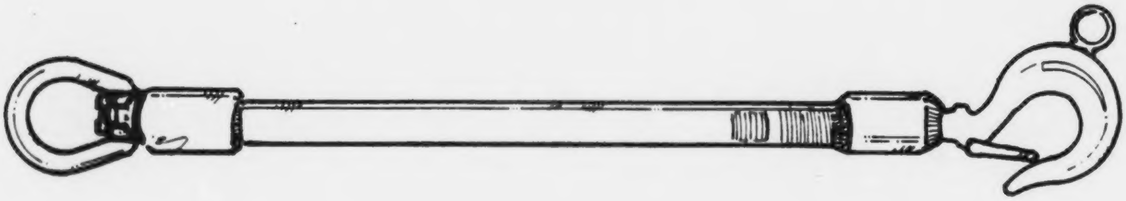

Hook
Outer Strap
Safety Catch
Inner Strap
Shell
Pin
Sheaves
Becket
Thimble

TM 2

May be photocopied for student use.

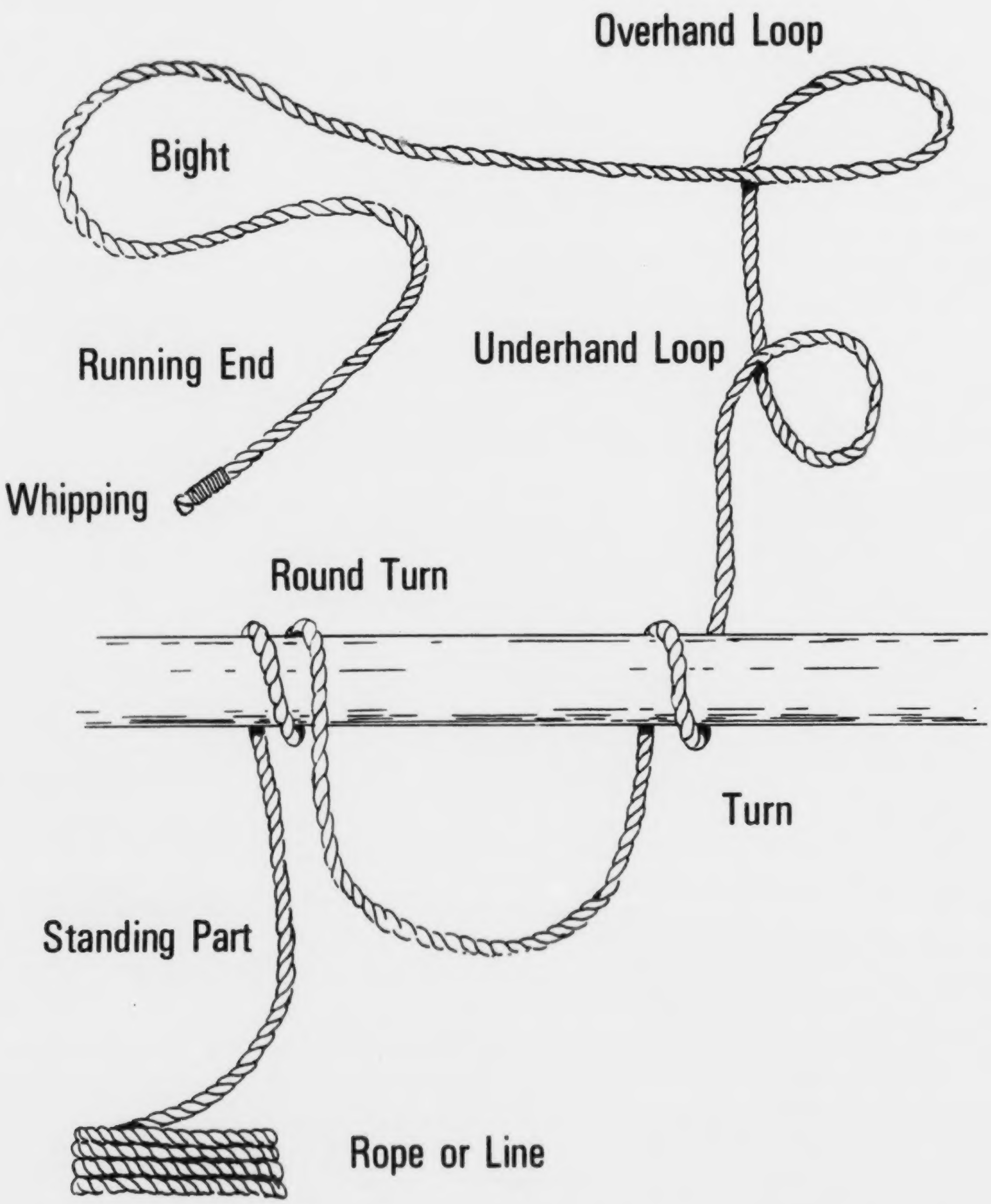
Use of Insulating Stick





TM 3

Elements of Knots, Bends, and Hitches


Overhand Loop
Bight
Running End
Underhand Loop
Whipping
Round Turn
Turn
Standing Part
Rope or Line

TM 4

May be photocopied for student use.

ROPE AND RIGGING
UNIT 4

TEST

NAME ______________________________ SCORE __________

1. Match the terms on the right to the correct definitions.

_____a. Anything that insulates; a nonconductor

_____b. Device to which the standing end of the rope in a block and tackle is secured

_____c. End of a block and tackle which is connected to the load to be moved

_____d. Greatest stress a rope can bear without breaking

_____e. Maximum load that should be applied to a rope

_____f. Rope to which pull is applied

_____g. To thread a rope around the sheaves in a set of blocks

_____h. Knot used to temporarily secure an object

_____i. Grooved wheel or pulley

_____j. A substance or thing that conducts

_____k. Pulley or combination of pulleys operated with a rope

_____l. Short piece of rope; rope whose ends have been spliced together to form an endless rope; rope with an eye in each end

1. Block and tackle
2. Sheave
3. Conductor
4. Becket
5. Fall line
6. Reeve
7. Fair lead
8. Traveling block
9. Insulator
10. Tensile strength
11. Hitch
12. Working load
13. Sling
14. Tag line
15. Hand line

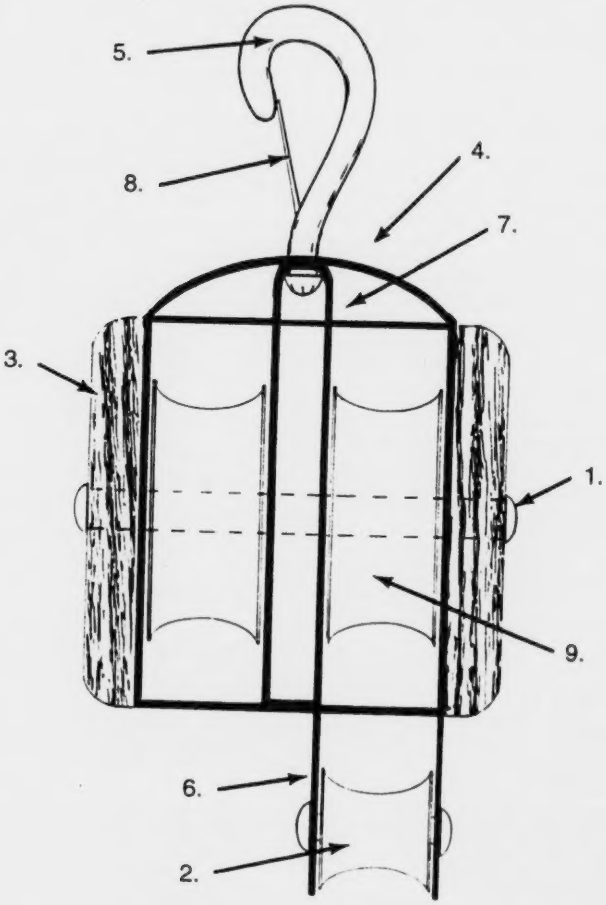
TEST

_____m. Use of a single line to apply pull more effectively

_____n. Rope used with single sheave block

_____o. Rope used to hold conductors away from pole

2. Identify the parts of the stationary block below by writing the correct name in the blanks.



1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________

May be photocopied for student use.

TEST

3. List four kinds of rope used in line work.

a. ______________

b. ______________

c. ______________

d. ______________

4. Determine the tensile strength of the following ropes by using the chart shown below.

Diameter	Manila	Nylon	Dacron	Polyethylene	Polypropylene
3/16″	450	960	720	700	740
1/4″	600	1,500	1,150	1,200	1,250
5/16″	1,000	2,400	1,750	1,750	1,900
3/8″	1,350	3,400	2,450	2,500	2,700
7/16″	1,750	4,800	3,400	3,400	3,550
1/2″	2,650	6,200	4,400	4,100	4,500
9/16″	3,450	8,000	5,700	5,100	5,400
5/8″	4,400	10,000	7,300	6,000	6,600
3/4″	5,400	14,000	10,000	7,500	8,000
7/8″	7,700	19,000	13,600	9,900	10,750
1″	9,000	24,000	16,500	11,000	12,500
1 1/8″	12,000	31,500	21,600	15,000	17,000
1 1/4″	13,500	36,000	24,400	17,300	19,500

a. 1/4″ manila — ______________________________

b. 1/4″ polyethylene — ______________________________

c. 1 1/4″ nylon — ______________________________

d. 3/4″ polypropylene — ______________________________

e. 3/8″ dacron — ______________________________

May be photocopied for student use.

TEST

5. Determine the mechanical advantage of using a 5 sheave block and tackle to lift a 500 lb load. Show your work.

6. List one use for each type of rope gear listed below.

   a. Block and tackle — ____________________

   b. Sling — ____________________

   c. Hand line — ____________________

   d. Tag line — ____________________

7. Apply the formula necessary for the safe working load of the following ropes, using a safety factor of 5.

   a. Manila rope with 450 lbs tensile strength

      Working load =

May be photocopied for student use.

TEST

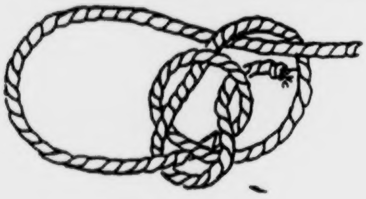
b. Nylon rope with 3400 lbs tensile strength

Working load =

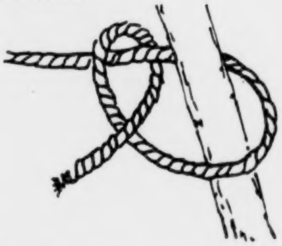
c. Polyethylene rope with 2500 lbs tensile strength

Working load =

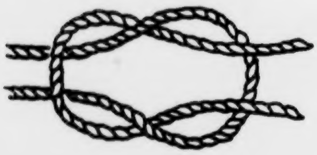
8. Identify the following knots and hitches.



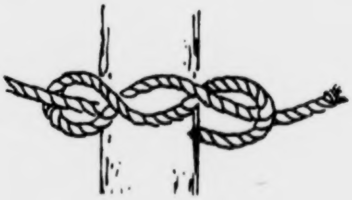
a. ____________



b. ____________

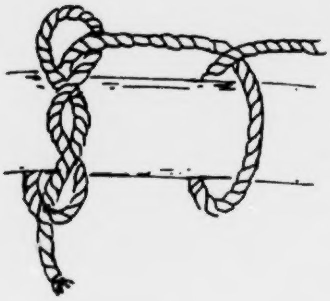


c. ____________

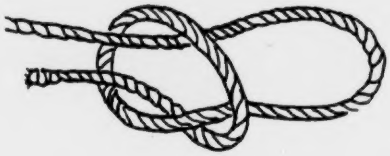


d. ____________

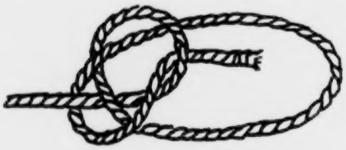
TEST



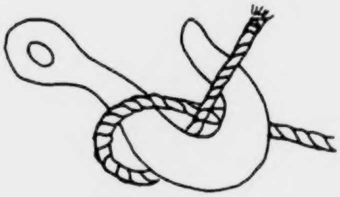
e. ______________



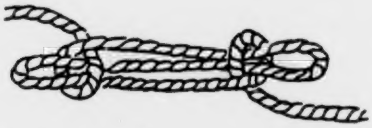
f. ______________



g. ______________



h. ______________



i. ______________

9. Match the types of knots and hitches on the right to the correct uses.

_____a. Raising poles

_____b. Securing to hook while under steady strain

_____c. Sending crossarm up pole

_____d. Sending tools and materials up pole

_____e. Tying for general purposes

_____f. Tying sling lines

1. Square knot
2. Bowline
3. Slip knot
4. Timber hitch
5. Half hitch
6. Running bowline

TEST

_____g. Tying to poles, pipe, or arms temporarily

_____h. Guying top of pole temporarily

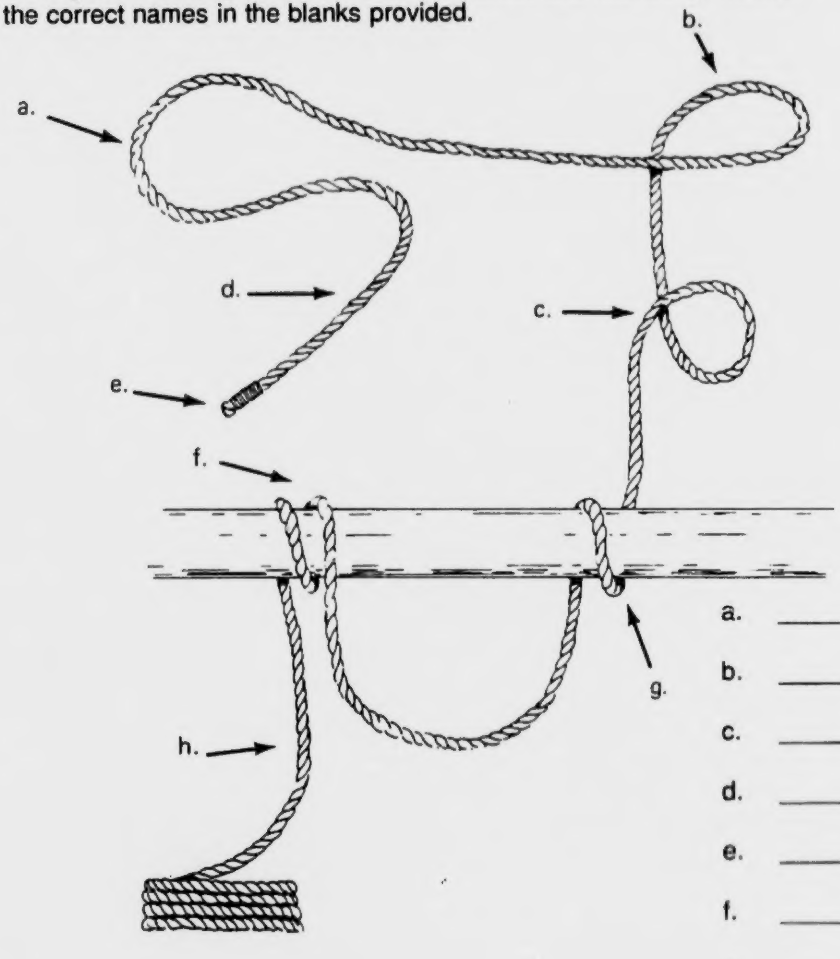
_____i. Shortening rope

7. Blackwall hitch

8. Sheepshank

9. Timber hitch with half hitch

10. Identify the following elements of knots, bends, and hitches by writing the correct names in the blanks provided.



a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

May be photocopied for student use.

TEST

11. List four conditions that damage rope.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

12. Evaluated on Assignment Sheet 1.

13. Evaluated on Assignment Sheet 2.

May be photocopied for student use.

OVERHEAD CONSTRUCTION
UNIT 5

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:
    - Provide student with objective sheet.
    - Provide student with information sheet.
    - Make transparencies.
    - Discuss unit and specific objectives.
    - Discuss information sheet.
    - Give test.
2. Unit references:
    - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

OVERHEAD CONSTRUCTION
UNIT 5

ANSWERS TO TEST

1.	a.	10	i.	5
	b.	9	j.	2
	c.	8	k.	1
	d.	6	l.	13
	e.	11	m.	14
	f.	7	n.	12
	g.	3	o.	16
	h.	4	p.	15
2.	a.	9	m.	20
	b.	6	n.	16
	c.	4	o.	17
	d.	1	p.	15
	e.	2	q.	18
	f.	5	r.	12
	g.	3	s.	14
	h.	7	t.	13
	i.	8	u.	22
	j.	10	v.	21
	k.	23	w.	11
	l.	19		

ANSWERS TO TEST

3. a. Ratchet wrench

   b. Folding skinning knife

   c. Line technician's hammer

   d. Adjustable wrench

   e. Folding wood rule

   f. Screwdriver

   g. Line technician's pliers

4. a. 6

   b. 1

   c. 4

   d. 3

   e. 5

   f. 2

   g. 7

5. a. Pole framing gin

   b. Pole jack

   c. Guy grip

   d. Bolt cutters

   e. Chain hoist

   f. Digging shovel

   g. Digging spoon

   h. Hot line wire grip

   i. Load binder and chain

   j. Cant hook

   k. Anchor auger

   l. Cable hoist

   m. Transformer gin

   n. Insulated strap hoist

ANSWERS TO TEST

o. Wire grip

p. Pole carrying hook

q. Tamp

r. Compression tool

s. Insulating stick

6. a. 11

b. 12

c. 5

d. 1

e. 8

f. 2

g. 6

h. 10

i. 3

j. 7

k. 14

l. 4

m. 9

n. 13

7. a. Pole loading, hauling, framing, setting, and removing

b. Anchor setting

c. Guy make-up and pulling

d. Conductor stringing, laying up, sagging, and tying in

8\.
- Hole digger derrick
- Pole truck and trailer
- Conductor-stringing truck
- Basket truck

9. a. 3

b. 1

c. 4

d. 2

ANSWERS TO TEST

10.

Length of Pole (feet)	Setting in Soil (feet)	Setting in All Solid Rock (feet)
20	4.0	3.0
25	5.0	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0
65	8.5	
70	9.0	
75	9.5	
80	10.0	
85	10.5	
90	11.0	
95	11.0	
100	11.0	

Pole setting depth for lengths of 65 feet or more may be decreased from soil setting depth by two feet when pole is set in solid rock.

a. 4.0　　c. 8.0

b. 6.0　　d. 5.5

11. a. Sighting

b. Return wave

c. Transit

d. Dynamometer

12. a. Compression sleeve

b. Ground rod clamp

c. U-bolt clamp

d. Compression fitting

e. Two bolt

ANSWERS TO TEST

f. Center bolt

g. Split bolt

h. Service entrance

13. a. 3 c. 2

b. 1 d. 4

14. a. Dig trench the required length at a right angle to conductor strain

b. Insert pole key in trench so that top of key is 12″ below ground

15. a. Dig trench 14″ deep and 30″ long parallel with overhead conductors

b. Drive ground rod into undisturbed soil 2′ from pole

16. a. 6 e. 2

b. 7 f. 3

c. 1 g. 5

d. 4

17. a. 69 kV two pole single circuit

b. 69 kV-230 kV steel pole single and double circuit

c. 69 kV single pole double circuit

d. 230 kV H-frame

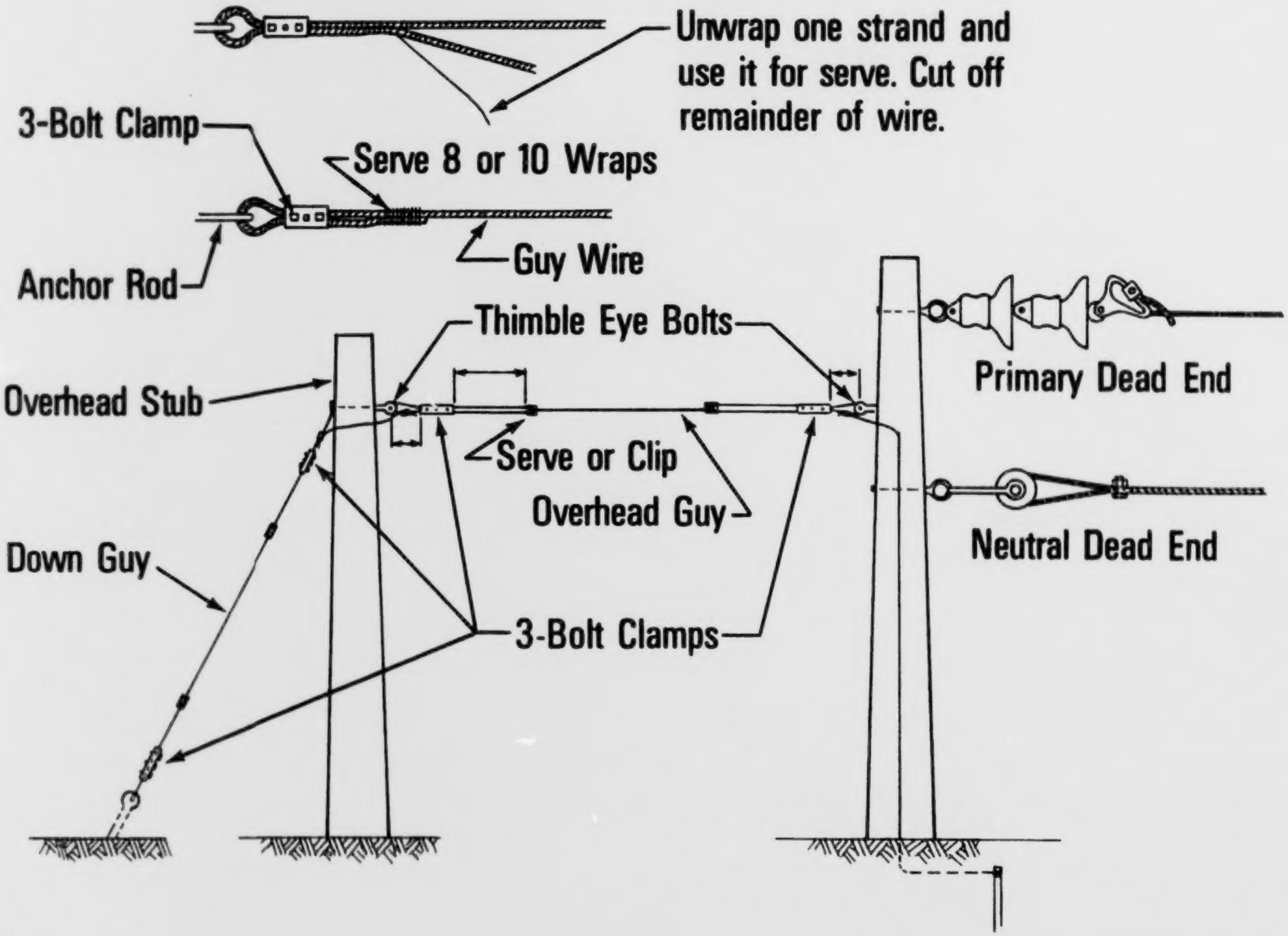
e. 115 kV steel tower single circuit

f. 115 kV H-frame

g. 69 kV single pole single circuit

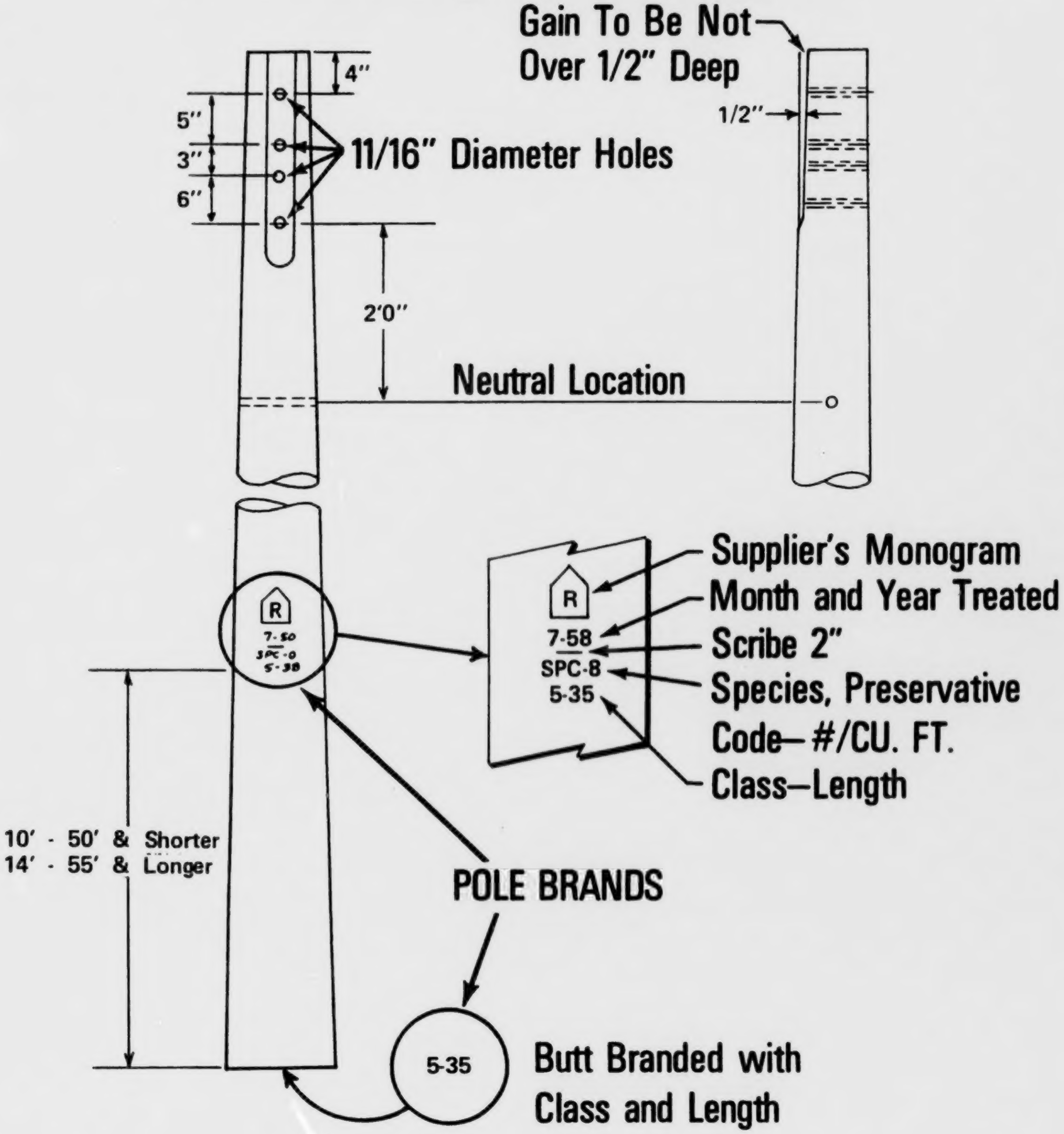
h. 345 kV steel tower double circuit

Overhead Stub with Dead Ends and Guys



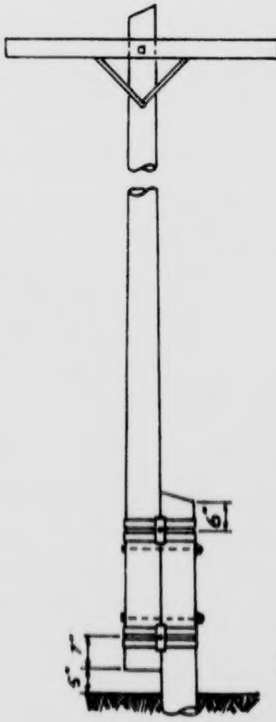
Unwrap one strand and use it for serve. Cut off remainder of wire.
3-Bolt Clamp
Serve 8 or 10 Wraps
Anchor Rod
Guy Wire
Thimble Eye Bolts
Overhead Stub
Primary Dead End
Serve or Clip
Overhead Guy
Neutral Dead End
Down Guy
3-Bolt Clamps

Pole Brand, Pole Gain, and Drilling Specifications

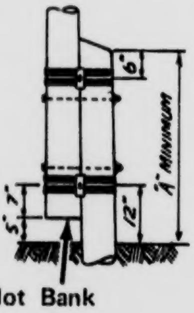

Gain To Be Not Over 1/2" Deep
4"
5"
3"
6"
1/2"
11/16" Diameter Holes
2'0"
Neutral Location
R
7-50
SPC-0
5-38
R
7-58
SPC-8
5-35
Supplier's Monogram
Month and Year Treated
Scribe 2"
Species, Preservative
Code– #/CU. FT.
Class–Length
10' - 50' & Shorter
14' - 55' & Longer
POLE BRANDS
5-35
Butt Branded with
Class and Length

Stub Pole

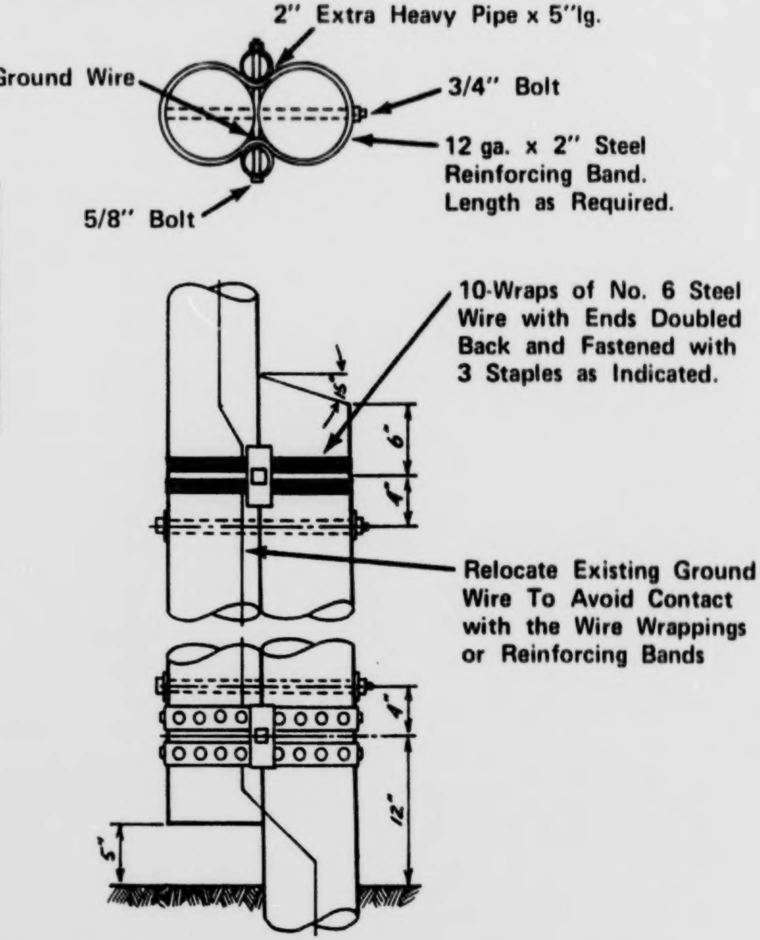
Length of Pole	A	Min. Total Length of Stub
30′	5′-0″	10′-6″
35′	5′-0″	11′-0″
40′	5′-6″	11′-6″
45′	6′-0″	12′-6″
50′	6′-0″	13′-0″



TYPE A

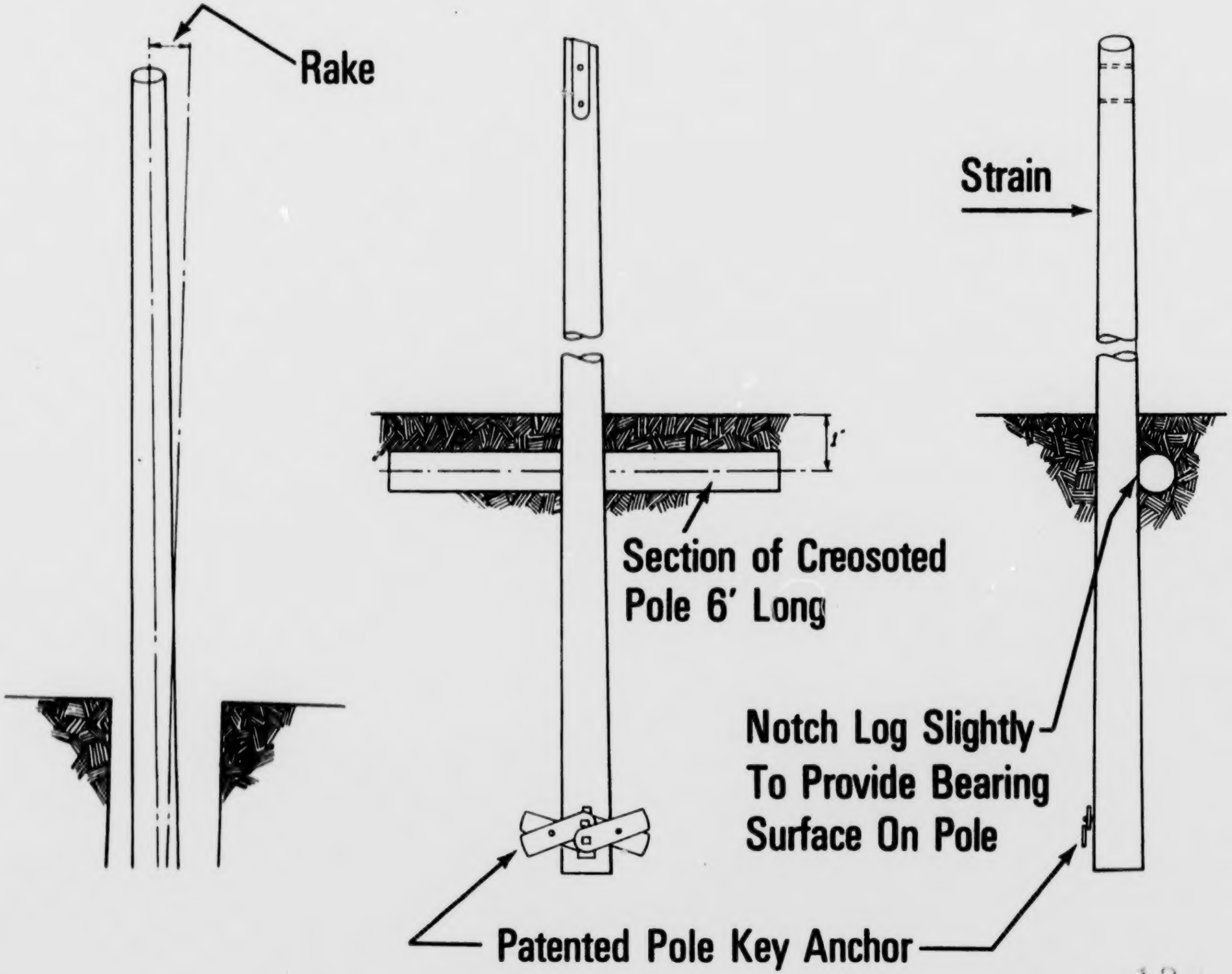

6"
"A" MINIMUM
12"
7"
5"
Do Not Bank

TYPE B

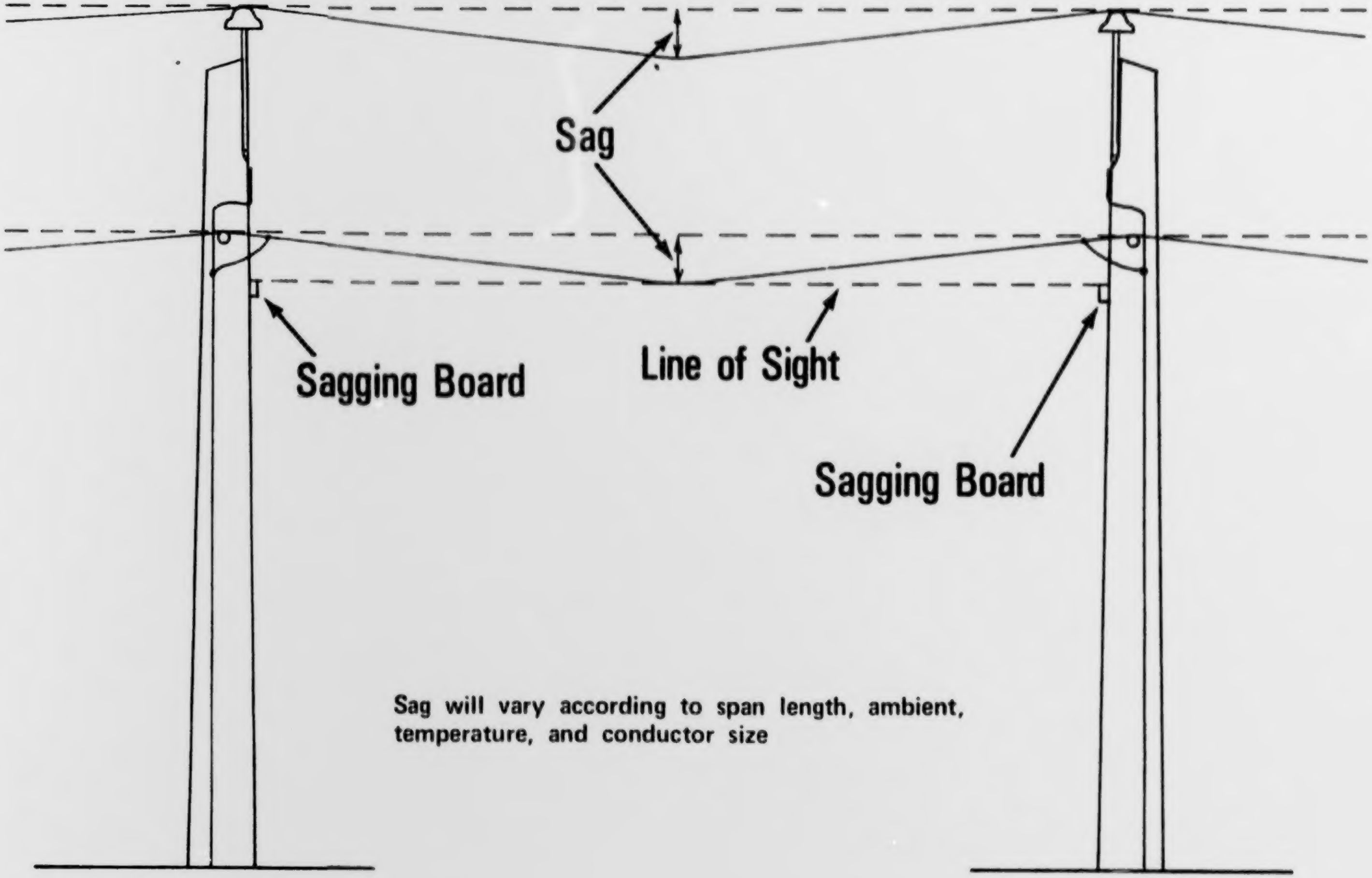

2" Extra Heavy Pipe x 5"lg.
Ground Wire
3/4" Bolt
12 ga. x 2" Steel Reinforcing Band. Length as Required.
5/8" Bolt
10-Wraps of No. 6 Steel Wire with Ends Doubled Back and Fastened with 3 Staples as Indicated.
4.5"
6"
4"
Relocate Existing Ground Wire To Avoid Contact with the Wire Wrappings or Reinforcing Bands
4"
12"
5"

Use either wire wrapping or reinforcing band for stubbing material as required. Position of stub at side of pole (At right angle to direction of line and outside of angle.)

Pole Rake and Pole Keys


Rake
Strain
1'
Section of Creosoted Pole 6' Long
Notch Log Slightly To Provide Bearing Surface On Pole
Patented Pole Key Anchor

Sag

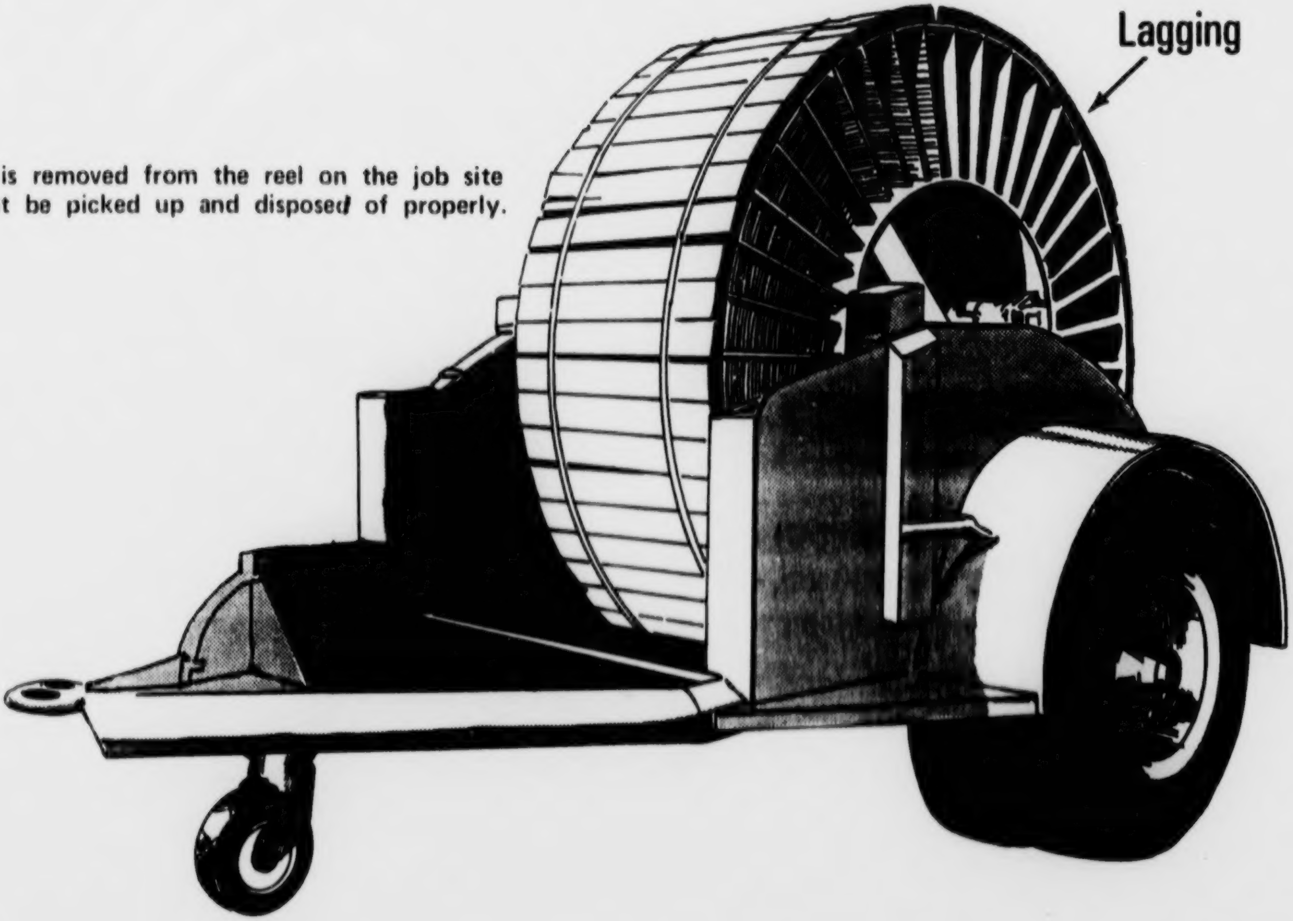

Sag
Sagging Board
Line of Sight
Sagging Board

Sag will vary according to span length, ambient, temperature, and conductor size

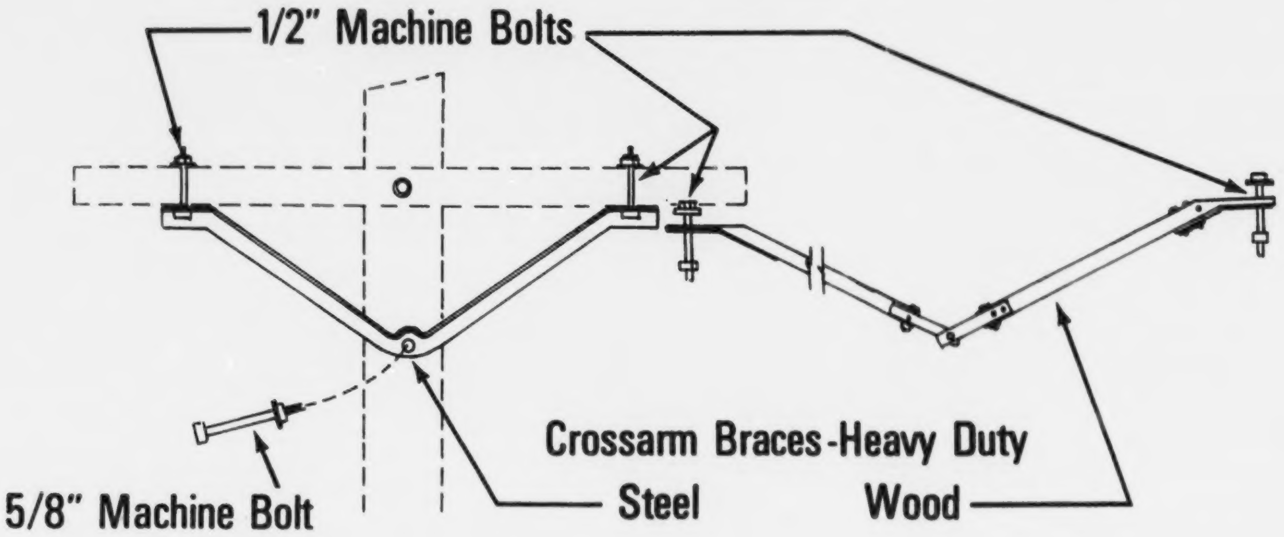
May be photocopied for student use.

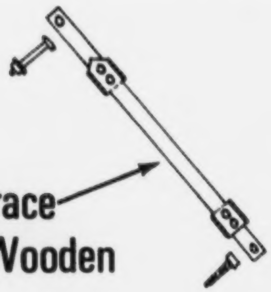
Lagging

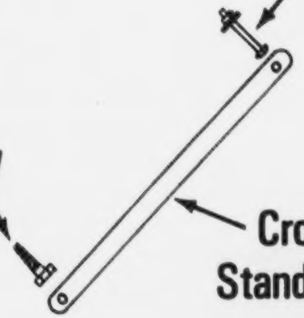
Lagging is removed from the reel on the job site and must be picked up and disposed of properly.



Materials Used in Overhead Construction

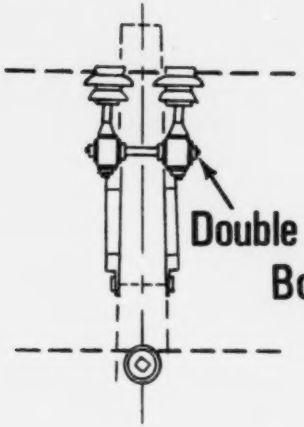

1/2" Machine Bolts
5/8" Machine Bolt
Crossarm Braces-Heavy Duty
Steel
Wood


Crossarm Brace
Standard Duty-Wooden

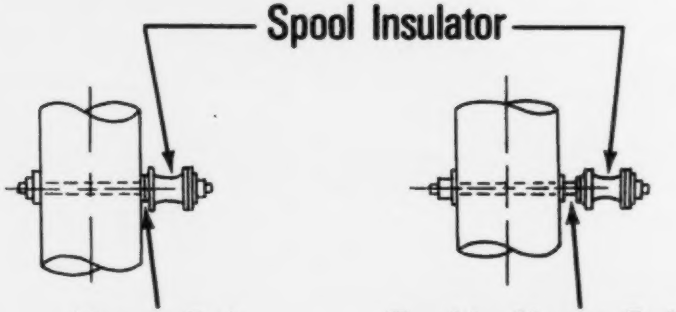

Carriage Bolt
Lag Screw
Crossarm Brace
Standard Duty-Steel

Materials Used in Overhead Construction

(Continued)



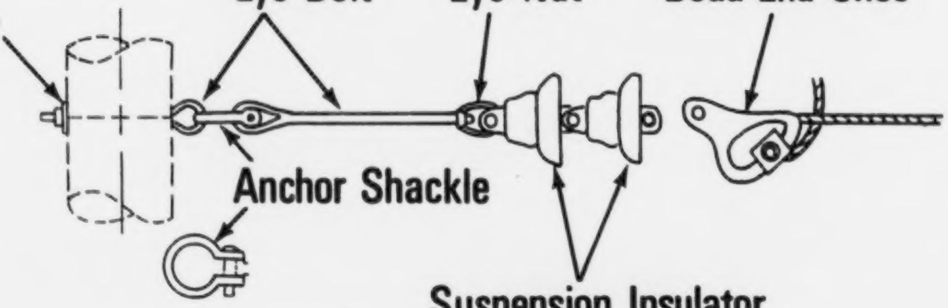
Double Arming Bolt



Spool Insulator

Upset Bolt

Double Upset Bolt



Square Washer

Eye Bolt

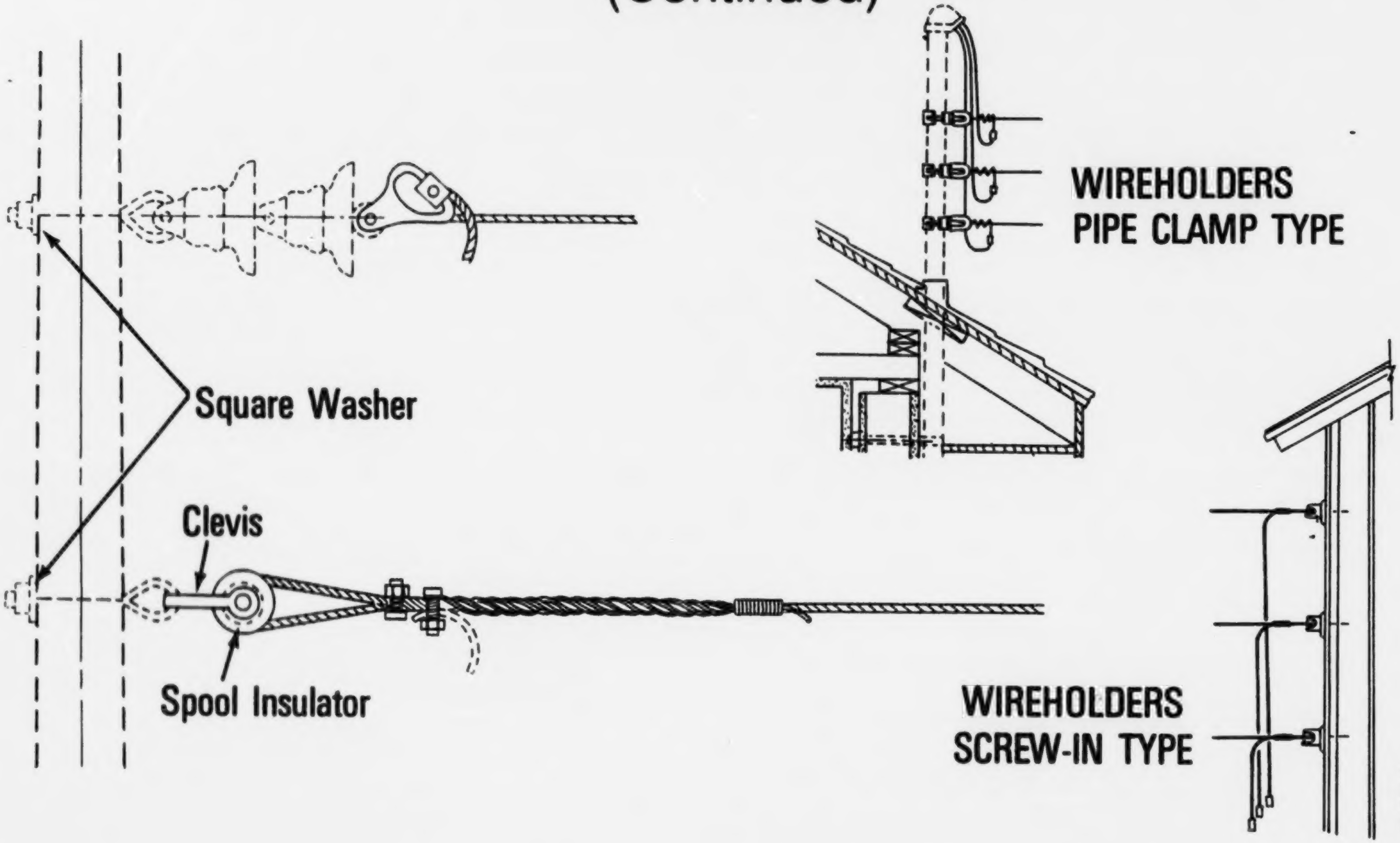
Eye Nut

Dead-End Shoe

Anchor Shackle

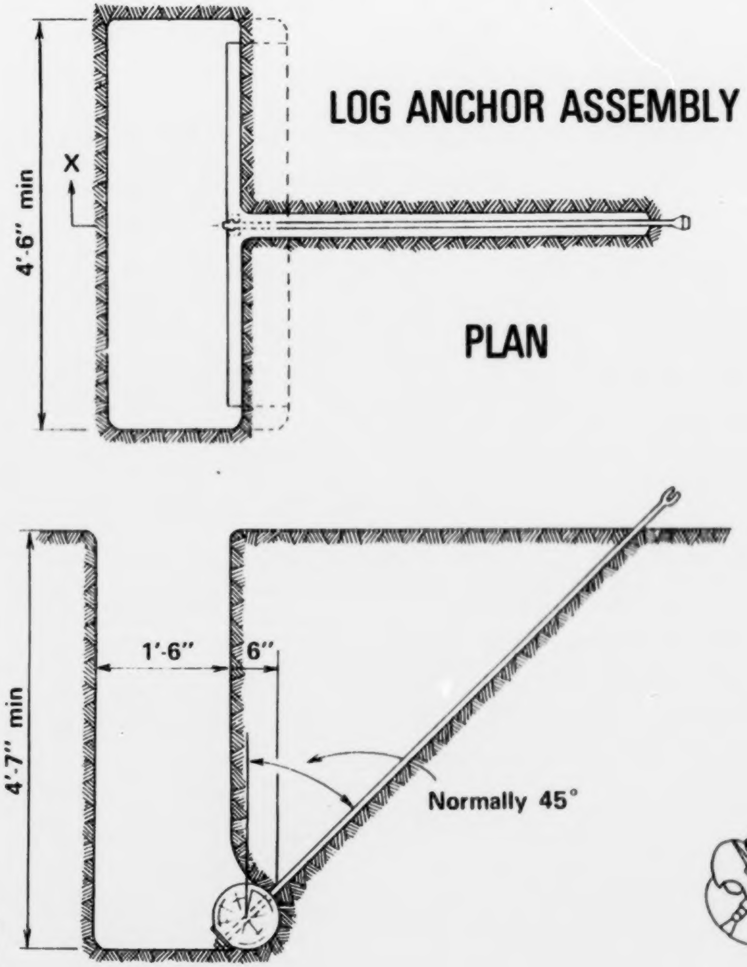
Suspension Insulator (Bells)

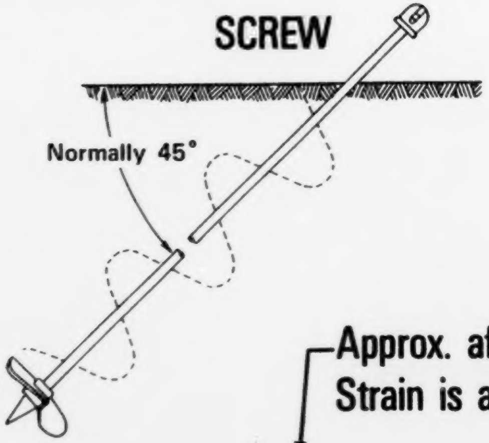
Materials Used in Overhead Construction
(Continued)

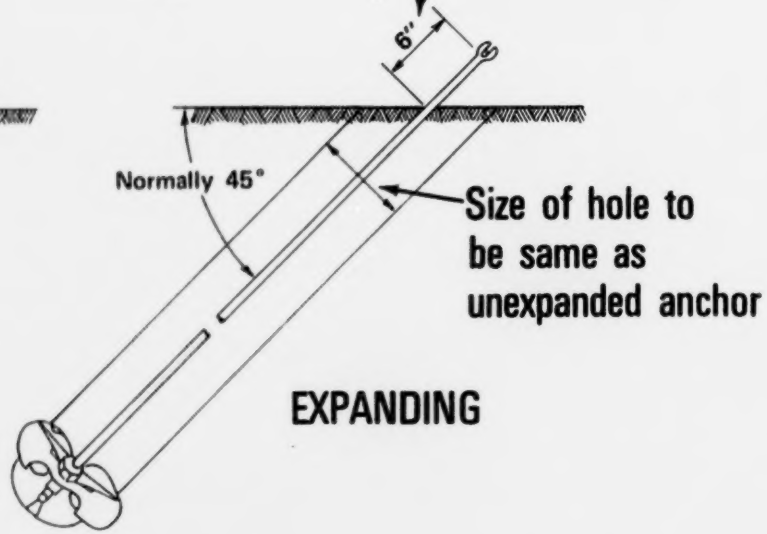

Square Washer
Clevis
Spool Insulator
WIREHOLDERS
PIPE CLAMP TYPE
WIREHOLDERS
SCREW-IN TYPE

May be photocopied for student use.

Anchor Assembly

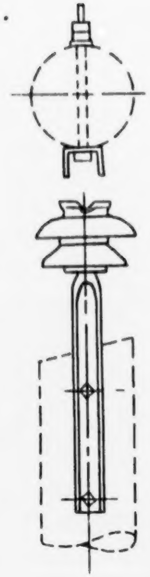

LOG ANCHOR ASSEMBLY
PLAN
4'-6" min
X
4'-7" min
1'-6"
6"
Normally 45°

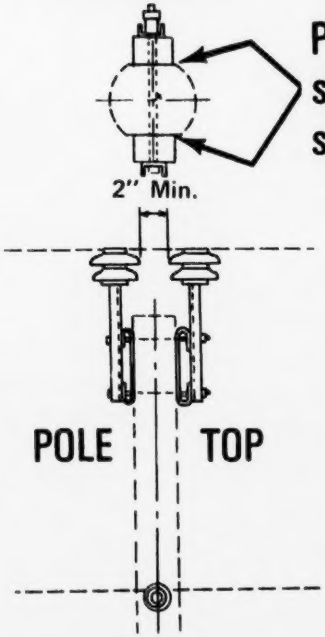

SCREW
Normally 45°


Approx. after
Strain is applied
6"
Normally 45°
Size of hole to
be same as
unexpanded anchor
EXPANDING

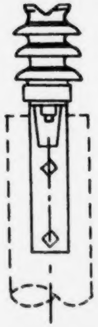
May be photocopied for student use.

Insulator Pins

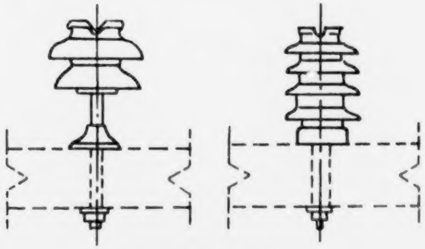




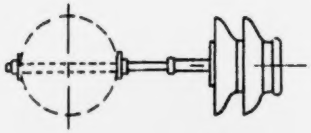
Pole to be gained on both sides to provide flat surfaces for the brackets.



Pole-Top Pins Are Referred To As Ridge Pins

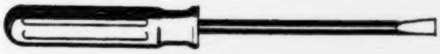


CROSSARM

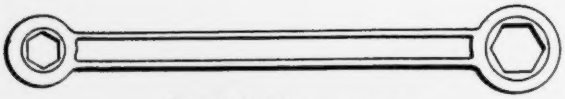


STAND OFF

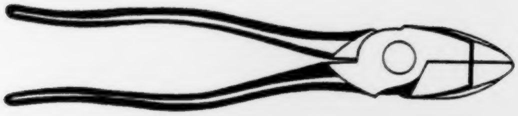
Hand Tools



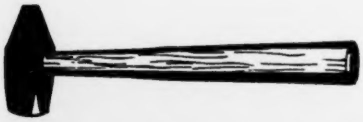
Screwdriver



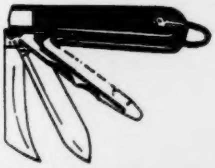
Ratchet wrench



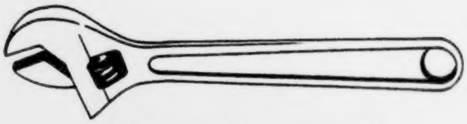
Line technician's pliers



Line technician's hammer



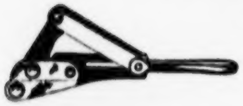
Folding skinning knife

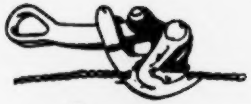


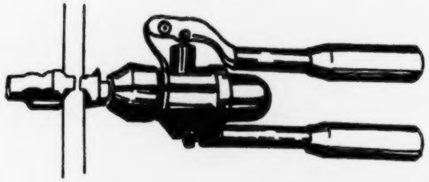
Adjustable wrench

Overhead Construction Tools

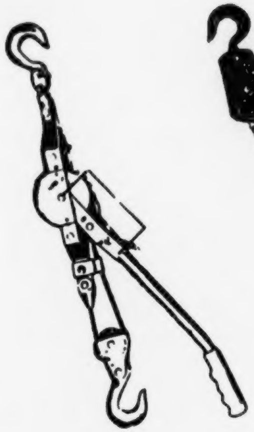
Pulling grips

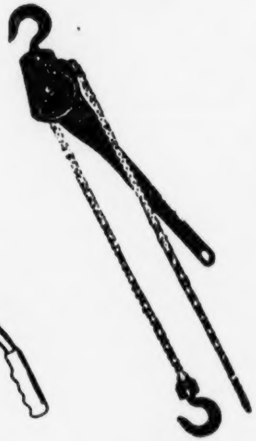

Wire grip

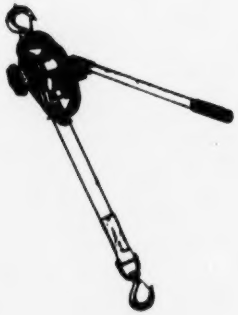

Guy grip

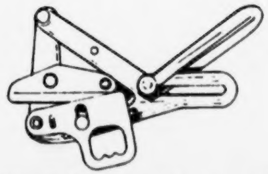

Compression tool

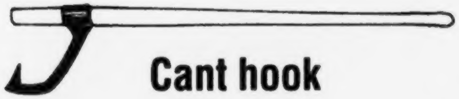
Hoists

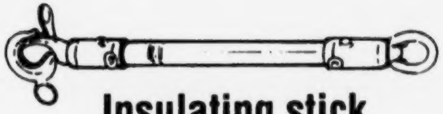

Cable hoist

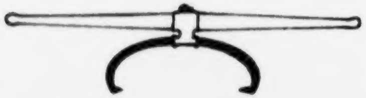

Chain hoist


Insulated strap hoist


Hot line wire grip


Cant hook

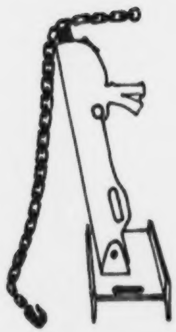

Insulating stick


Pole carrying hook

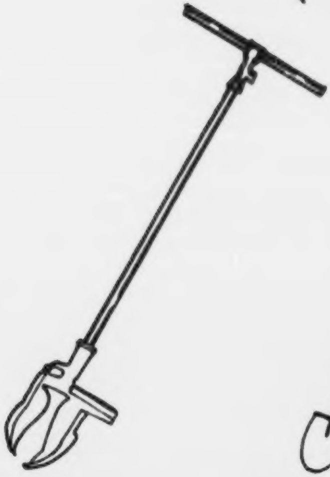
May be photocopied for student use.

Overhead Construction Tools

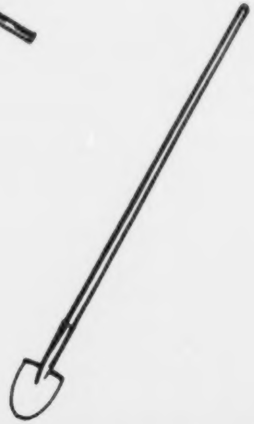
(Continued)



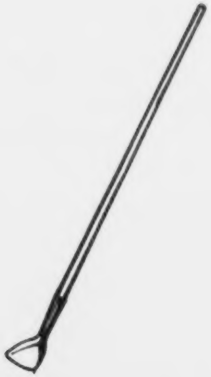
Pole jack



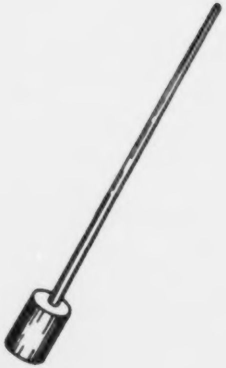
Anchor auger



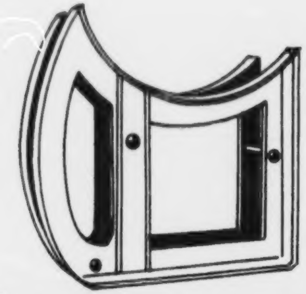
Digging shovel



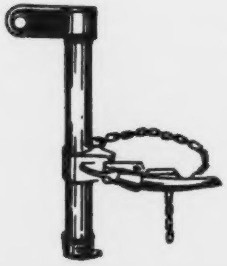
Digging spoon



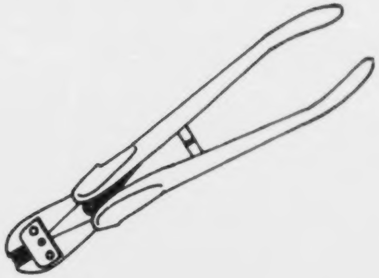
Tamp



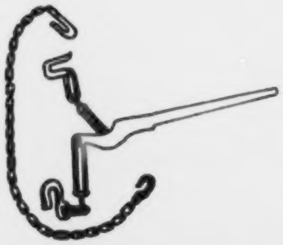
Pole framing gin



Transformer gin

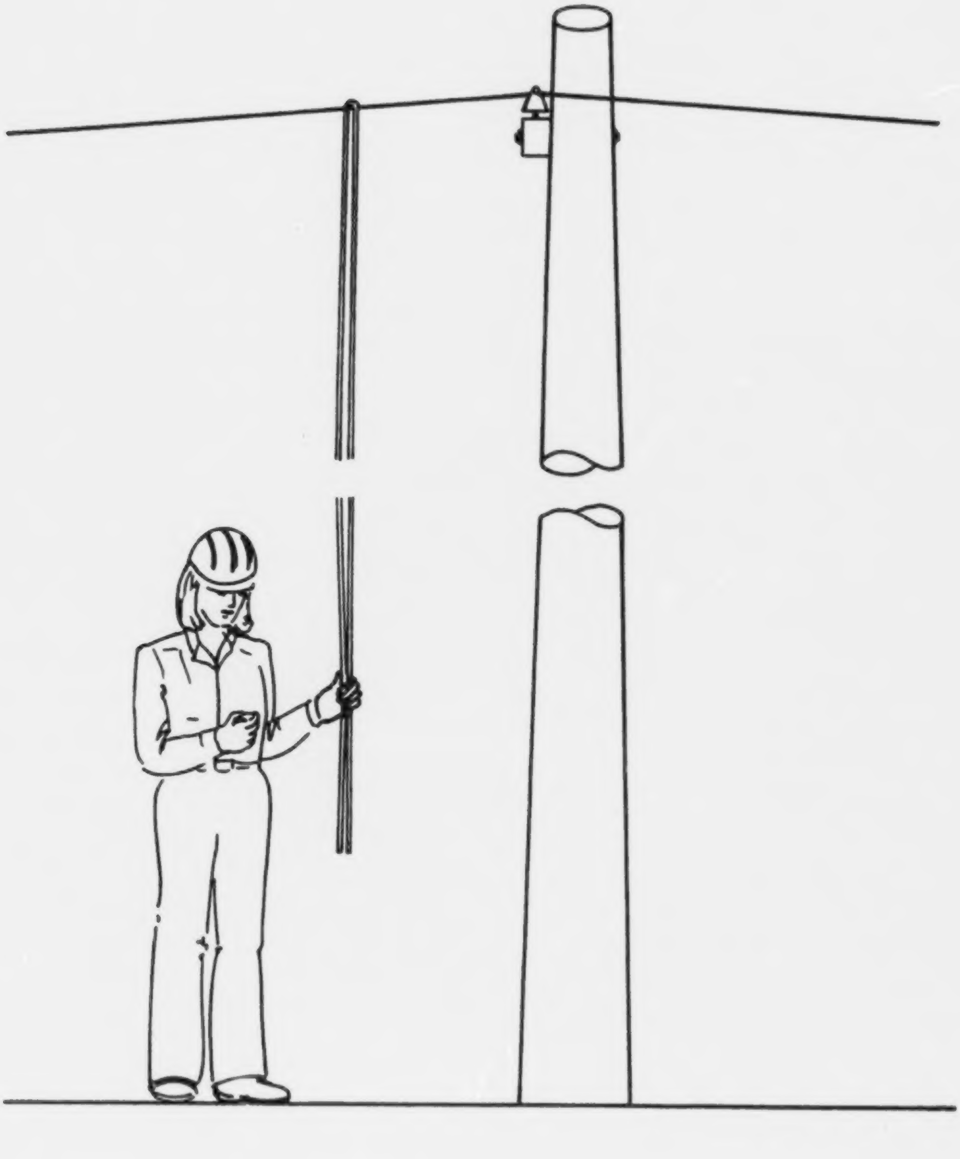


Bolt cutters



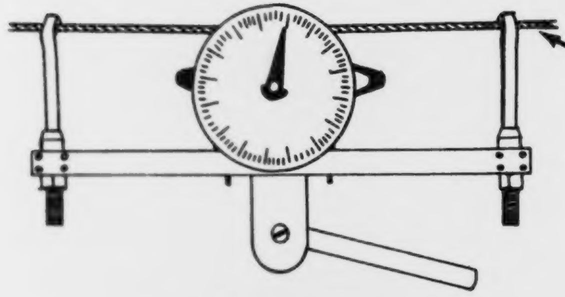
Load binder and chain

Checking Sag by Return Wave

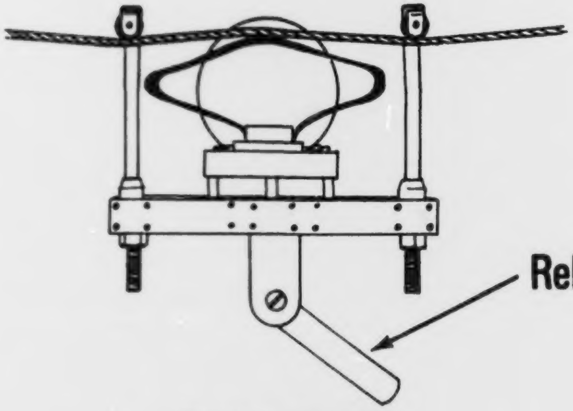


May be photocopied for student use.

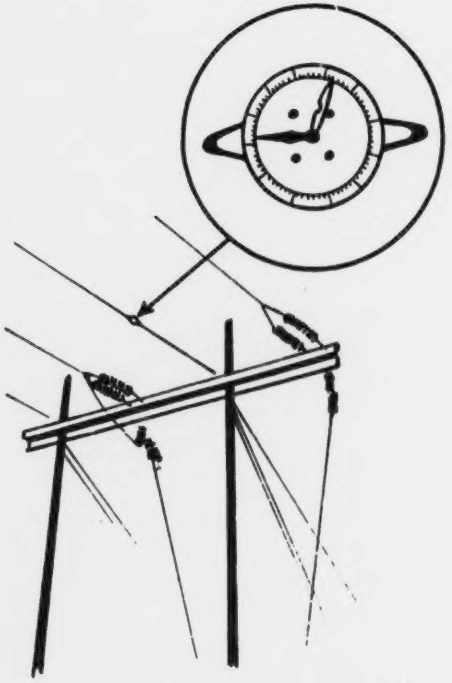
Dynamometer



FRONT VIEW

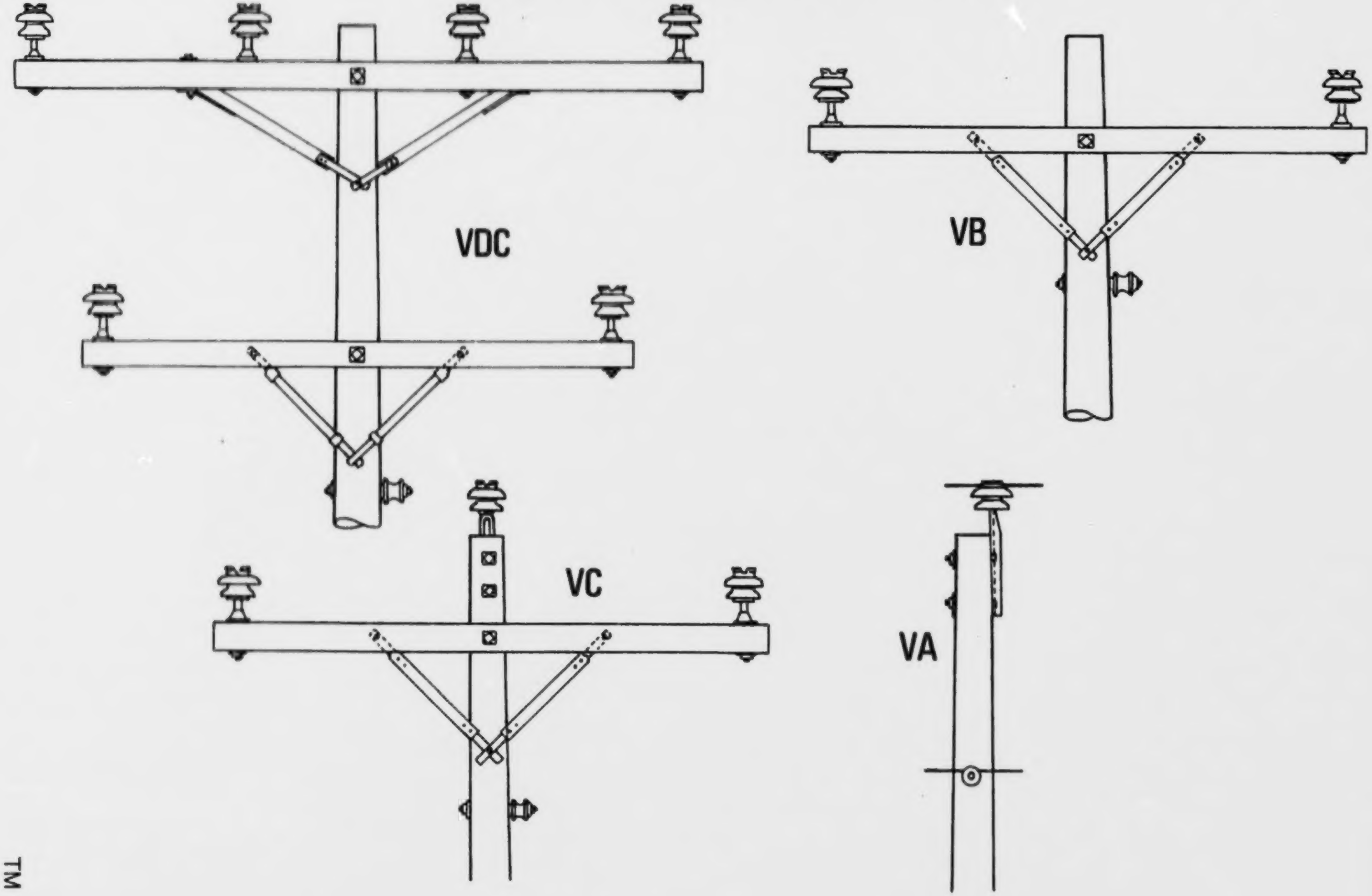

Release Handle

REAR VIEW

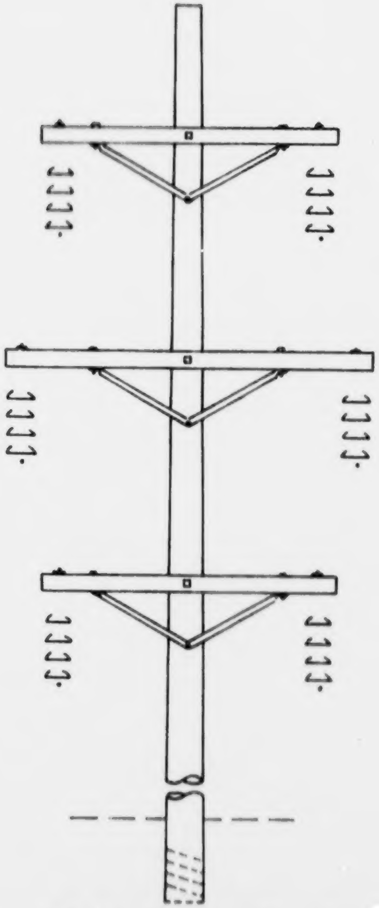


May be photocopied for student use.

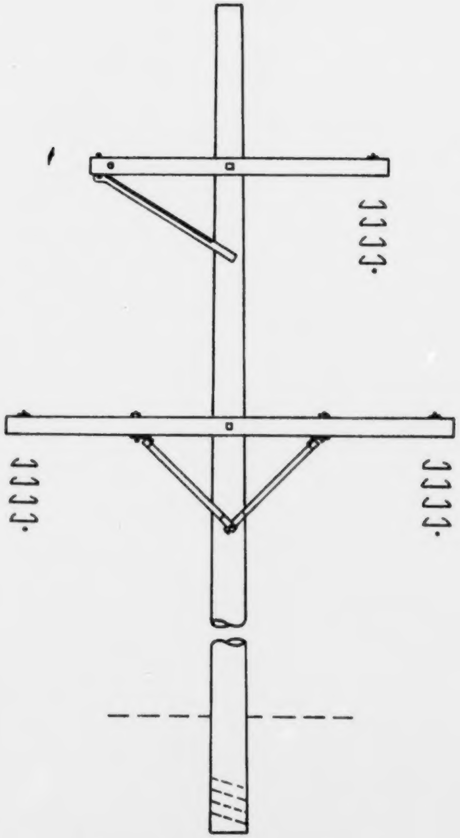
Types of Construction



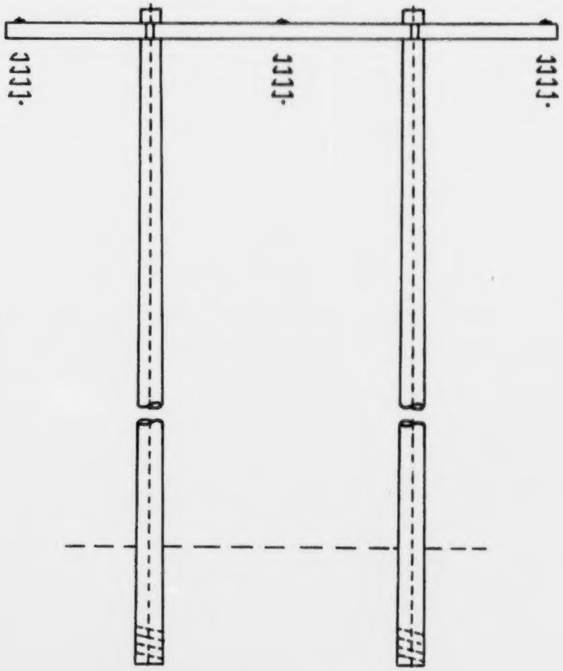
Transmission Line Structures



69 kV Double Circuit
Single Pole

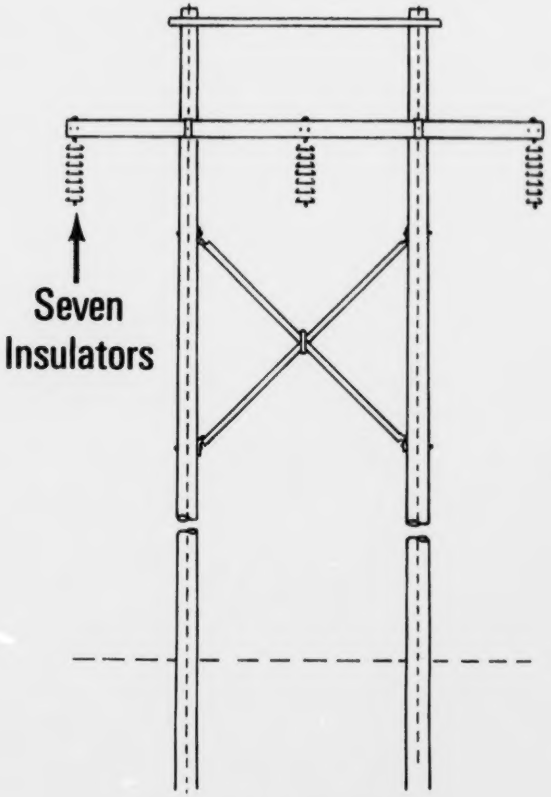


69 kV Single Circuit
Single Pole

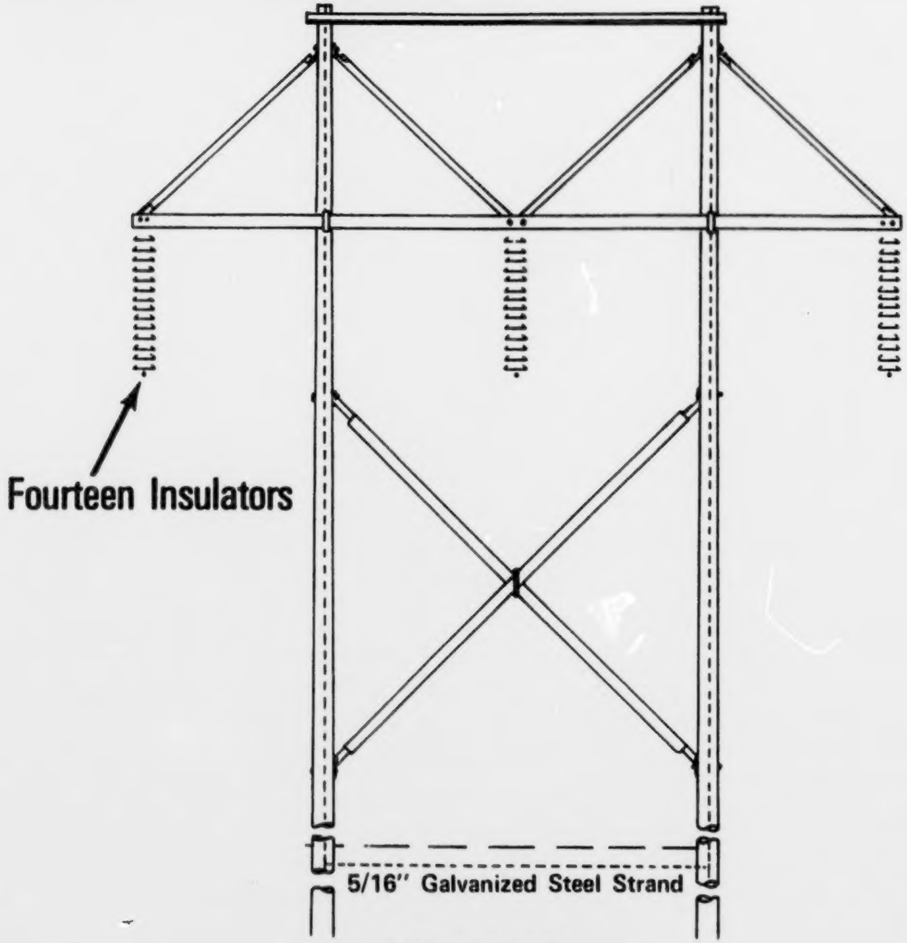


69 kV Two Pole Single Circuit

Transmission Line Structures

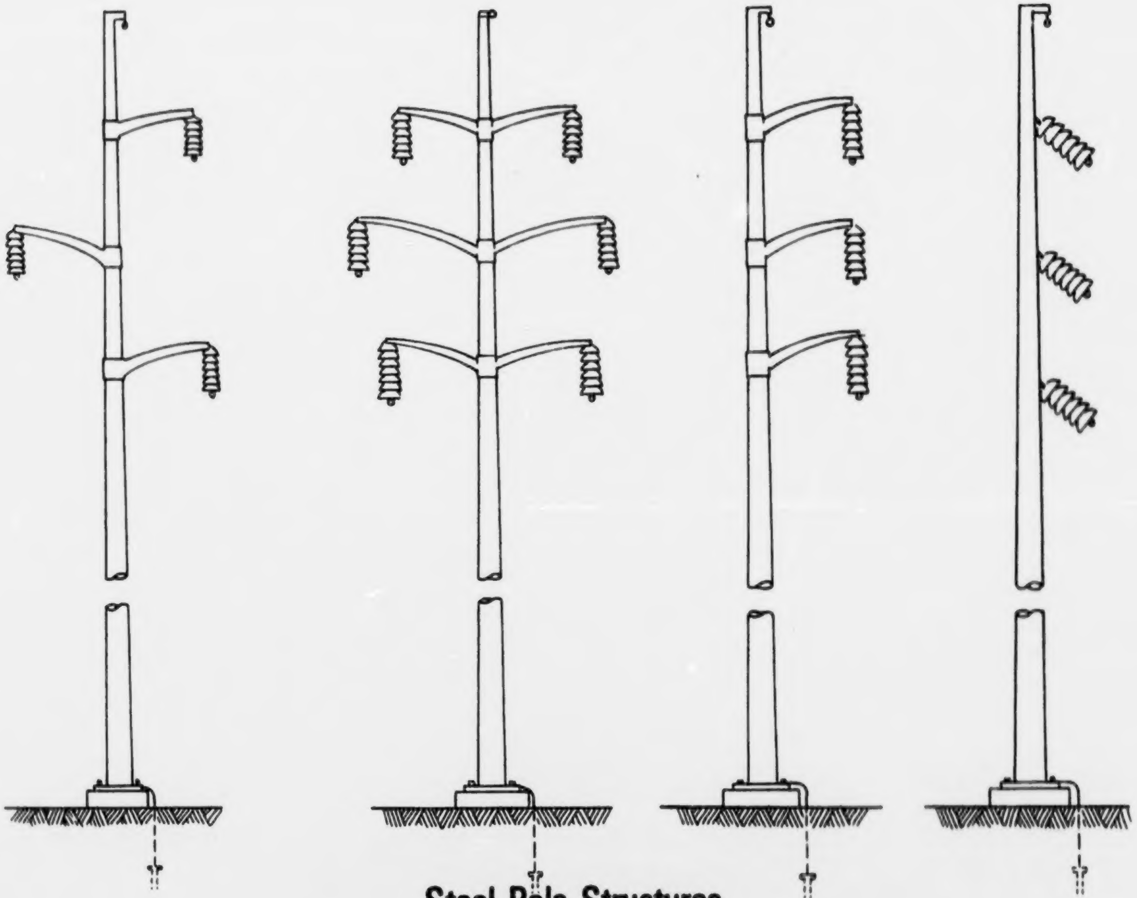

Seven Insulators

115 kV H-Frame


Fourteen Insulators
5/16" Galvanized Steel Strand

230 kV H-Frame

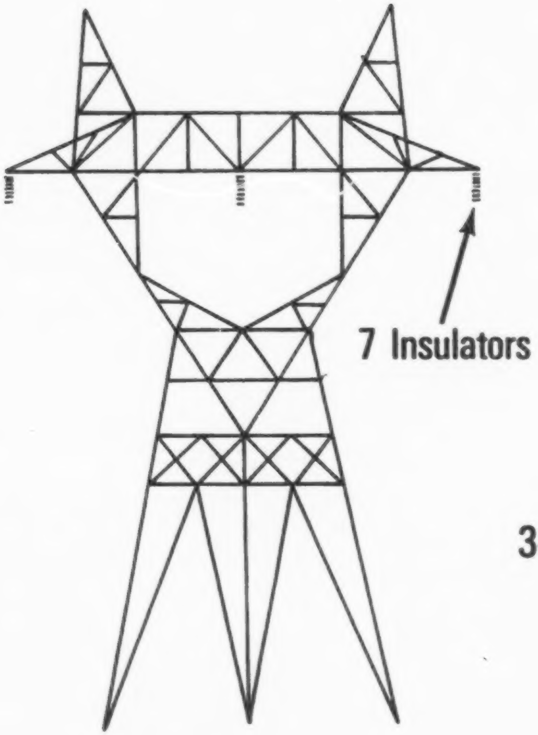
Transmission Line Structures



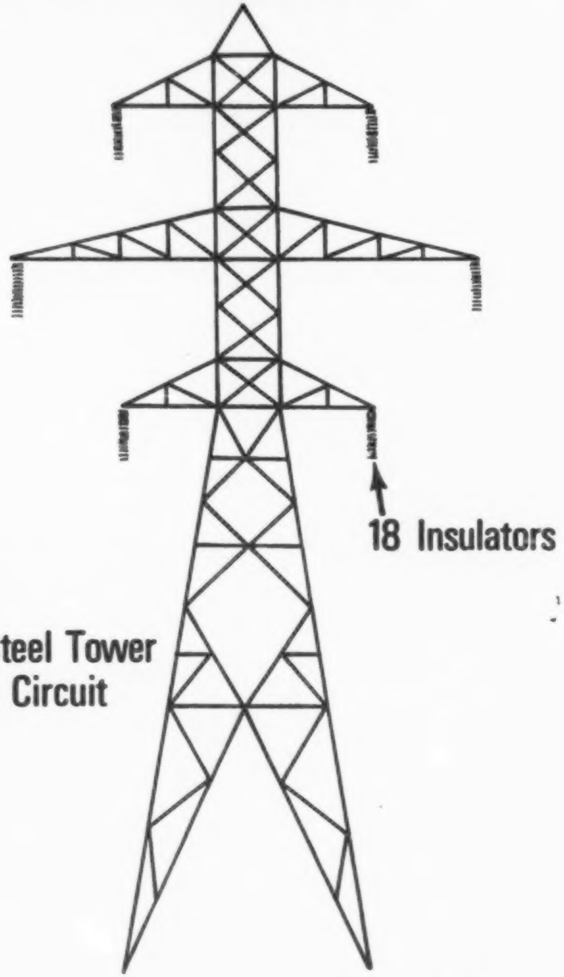
Steel Pole Structures

These structures may be used for 69 through 230 kV. The higher the voltage the greater the separation between conductors and between the conductors and the structure.

Transmission Line Structures


7 Insulators

115 kV Steel Tower
Single Circuit


18 Insulators

345 kV Steel Tower
Double Circuit

OVERHEAD CONSTRUCTION
UNIT 5

TEST

NAME ______________________________ SCORE ____________

1. Match the terms on the right to the correct definitions. (Answers to "a" through "k" are on this page.)

_____a. Pole used to elevate guy wire over roadways or obstructions

_____b. Strong steel wire used to hold against conductor strain between pole and anchor

_____c. Marking found on pole which gives the kind of wood, the date pole was treated, the manufacturer, and the length and class of pole

_____d. Place in the line where the conductor is connected to an attachment and may or may not continue to other poles

_____e. Area at the top of a pole which is planed and drilled for crossarm or hardware attachment

_____f. Short length of pole strapped and bolted to an existing pole for support

_____g. Removing bark, trimming, gaining, boring holes, and attaching grounds and hardware

_____h. Aligning the holes in a pole with the conductor or at an angle to the conductor

_____i. To lean a pole against conductor strain

_____j. Using a long, round pole with a pointed metal spike on one end to plumb or hold a pole straight while setting

_____k. Section of pole or a treated plank used to brace a pole

1. Pole key
2. Piking
3. Framing
4. Canting
5. Rake
6. Dead end
7. Stub pole
8. Pole brand
9. Guy strand
10. Overhead stub
11. Pole gain

TEST

_____l. Distance between a straight line and where the conductor is recommended to be hung

_____m. Pulley mounted on a crossarm or pole to string conductor through when stringing long runs of conductor

_____n. Soft wood planks nailed or strapped across conductor reels to protect the conductor

_____o. Line which carries power over great distances between generation plant and substations

_____p. Line which carries 2,300 to 34,500 volts of power throughout urban and rural areas

12. Lagging
13. Sag
14. Dolly
15. Distribution line
16. Transmission line

2. Match the materials on the right to the correct uses. (Answers for "a" through "i" are on this page.)

_____a. Attaches hardware and equipment to poles

_____b. Used in heavier distribution and transmission line construction and for pole stubbing

_____c. Used to bolt heavy-duty crossarm braces to crossarm

_____d. Used to bolt standard crossarm braces to crossarm.

_____e. Used to bolt crossarms together when two or more crossarms are used

_____f. Used where a dead end in the primary or neutral is constructed

_____g. Used on the back side of an eye bolt when a double dead end is constructed

_____h. Used in the neutral position on primary structure for attaching the neutral conductor

1. 3/8″ carriage bolt
2. Double arming bolt
3. Eye nut
4. 1/2″ machine bolt
5. Eye bolt
6. 3/4″ machine bolt
7. Upset bolt
8. Double upset bolt
9. 5/8″ machine bolt

TEST

______i. Used to hold conductor an extended distance from pole

______j. Used to secure conductor at a dead end

______k. Used to hold a spool insulator

______l. Used with both large and small clevises for service dead ends and neutral dead ends and on upset bolts

______m. Used for screwing into wood or clamping around pipe

______n. Used with all bolts when nut does not tighten against other hardware

______o. Used to connect eye bolts or eye bolt and eye nut together

______p. Used to dead end or suspend conductor on angle poles or is hung below crossarm to suspend conductor on higher voltage systems

______q. Used with a rod for attaching guy wire to hold against conductor strain

______r. Used on a crossarm to attach an insulator

______s. Connects conductors together which are not under strain

______t. Used on all bolts

______u. Bolts to top of pole to hold insulator

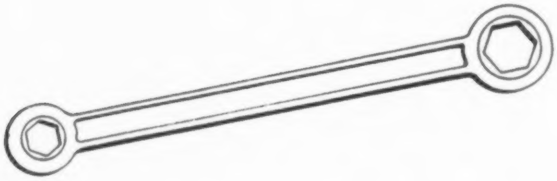
______v. Fastens to the bottom of a pole for a ground

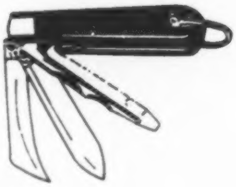
______w. Used with guy wire on overhead guys

10. Dead-end shoe
11. Thimble eye bolt
12. Insulator pin
13. Locknut
14. Connector
15. Suspension insulator (bell)
16. Square washer
17. Anchor shackle
18. Anchor
19. Spool insulator
20. Wire holder
21. Butt plate
22. Pole top pin
23. Clevis

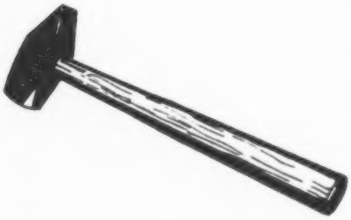
TEST

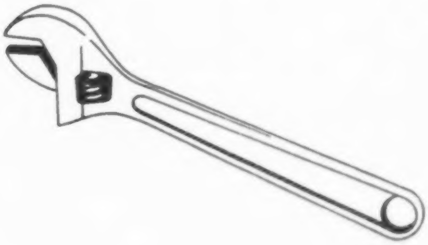
3. Identify the following hand tools used in overhead construction.



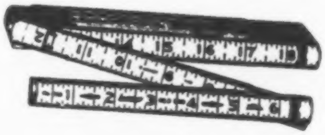


a. ____________________ b. ____________________

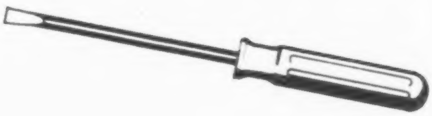


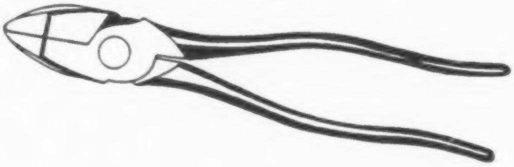


c. ____________________ d. ____________________



e. ____________________





f. ____________________ g. ____________________

TEST

4. Match the hand tools on the right to their specific uses.

_____a. Cuts and serves soft wire

_____b. Drives and removes screws

_____c. Drives lag screws and steeples

_____d. Loosens and tightens connectors, bolts, and nuts

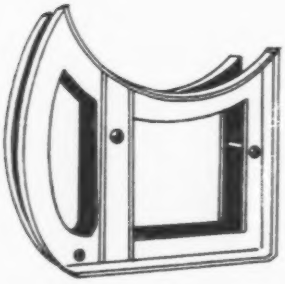
_____e. Tightens nuts and connectors

_____f. Removes insulation

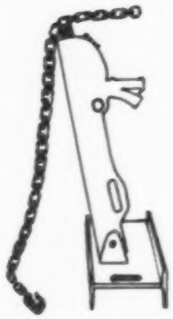
_____g. Measures spacing for material

1. Screwdriver
2. Skinning knife
3. Ratchet wrench
4. Line technician's hammer
5. Adjustable wrench
6. Line technician's pliers
7. Folding wood rule

5. Identify the following overhead construction tools.

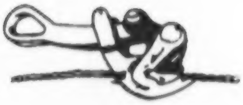


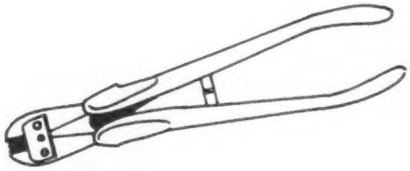
a. ____________________



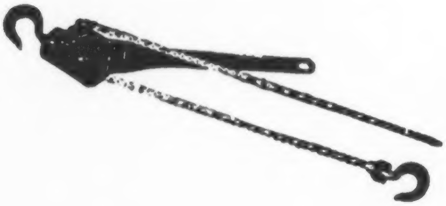
b. ____________________

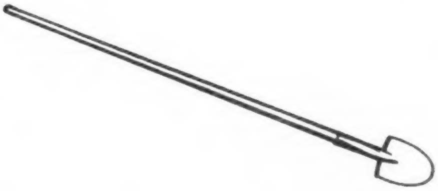
TEST



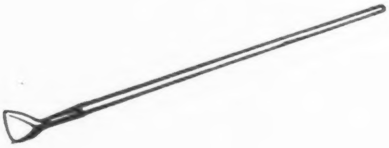


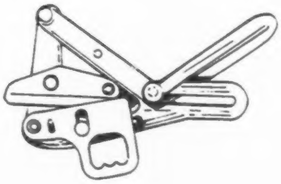
c. ______________________ d. ______________________



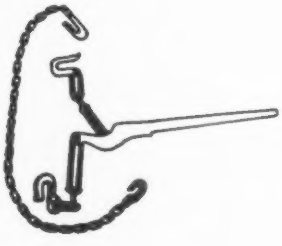


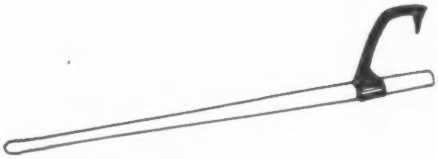
e. ______________________ f. ______________________





g. ______________________ h. ______________________

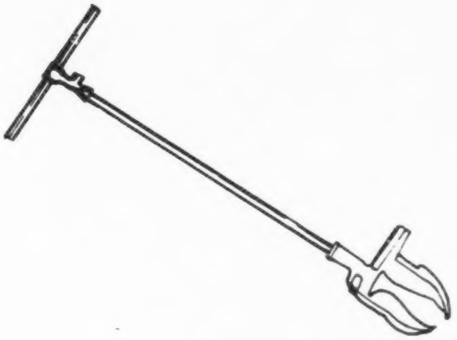


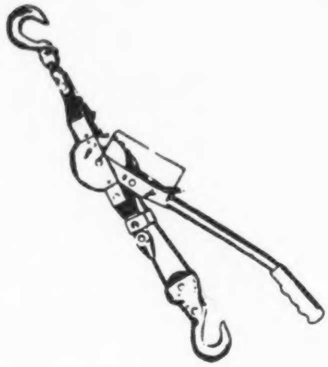


i. ______________________ j. ______________________

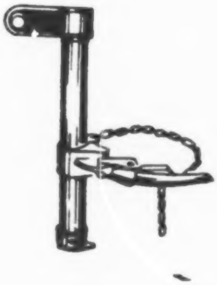
May be photocopied for student use.

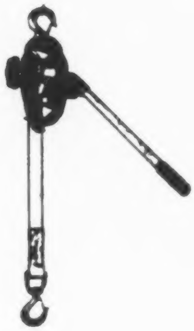
TEST



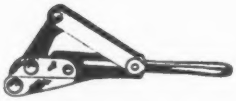


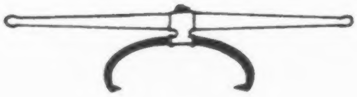
k. ______________________ l. ______________________





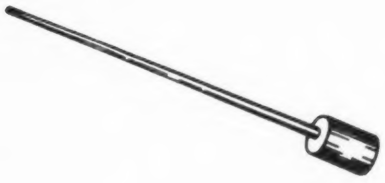
m. ______________________ n. ______________________



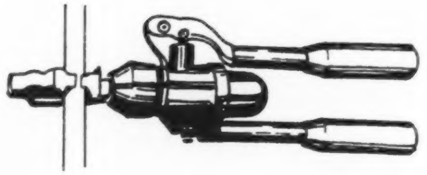


o. ______________________ p. ______________________

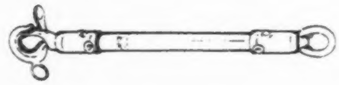
TEST



q. ____________________



r. ____________________



s. ____________________

6. Match the overhead construction tools on the right to their specific uses.

_____a. Attaches to conductor and is used with hoist or block and tackle to pull conductor or guy wire

_____b. Pulls tension on conductor or guy wire

_____c. Turns poles

_____d. Carries poles

_____e. Pulls or straightens poles

_____f. Digs anchor holes

_____g. Digs pole holes

_____h. Removes loose dirt from pole holes

_____i. Packs soil around poles or on anchors

_____j. Elevates and holds pole while framing material is being installed

_____k. Attaches to pole to hold block and tackle for lowering or raising transformer

1. Pole carrying hook
2. Anchor auger
3. Tamp
4. Bolt cutters
5. Cant hook
6. Digging shovel
7. Pole framing gin
8. Pole jack
9. Load binder and chain
10. Digging spoon
11. Pulling grip
12. Hoist

TEST

_____l. Cuts guy wire and heavy conductor

_____m. Binds poles to truck or pole trailer

_____n. Crimps sleeves and connectors

13. Compression tool

14. Transformer gin

7. List four elements of overhead construction

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

TEST

8. List equipment used in overhead construction.

- ______________________________
- ______________________________
- ______________________________
- ______________________________

9. Match the equipment on the right to the specific uses.

_____a.	Digs pole and anchor holes; sets and pulls poles	1.	Pole truck and trailer
_____b.	Carries poles and materials to job site	2.	Basket truck
_____c.	Carries reels of primary and service conductor to job site	3.	Hole digger derrick
_____d.	Assists the technician in reaching and working near energized conductors	4.	Conductor-stringing truck and trailer

TEST

10. Select from the following chart the correct depth to set the poles listed below.

Length of Pole (feet)	Setting in Soil (feet)	Setting in All Solid Rock (feet)
20	4.0	3.0
25	5.0	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0
65	8.5	
70	9.0	
75	9.5	
80	10.0	
85	10.5	
90	11.0	
95	11.0	
100	11.0	

Pole setting depth for lengths of 65 feet or more may be decreased from soil setting depth by two feet when pole is set in solid rock.

_____a. 35-foot pole in solid rock

_____b. 40-foot pole in soil

_____c. 80-foot pole in solid rock

_____d. 30-foot pole in soil

11. List four methods used to sag conductor.

a. ____________________

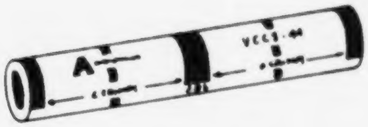
b. ____________________

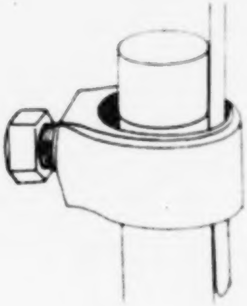
c. ____________________

d. ____________________

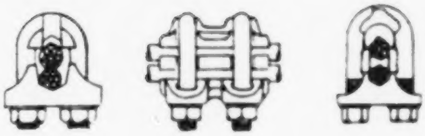
TEST

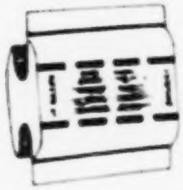
12. Identify the following connectors used in overhead construction.



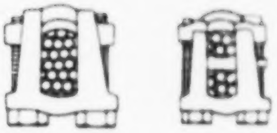


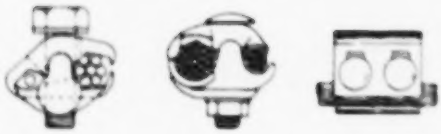
a. ____________________ b. ____________________





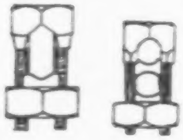
c. ____________________ d. ____________________



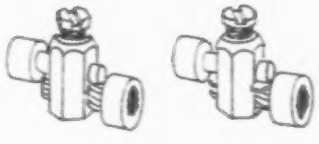


e. ____________________ f. ____________________

TEST



g. ____________________



h. ____________________

13. Match the types of construction on the right to the correct descriptions.

_____a. Three primary conductors with one neutral conductor

_____b. One primary conductor with one neutral conductor

_____c. Two primary conductors with one neutral conductor

_____d. Six primary conductors with one neutral conductor

1. VA
2. VB
3. VC
4. VDC

14. List two steps to install a pole key.

a. ____

b. ____

15. State the correct procedure for installing a ground rod.

a. ____

b. ____

16. Arrange in order the steps to follow when framing a pole by writing the number of the step in the blank provided.

_____a. Install crossarm, if required

_____b. Check pole ground for clearance between pole ground and hardware

_____c. Roll pole onto framing gin with cant hook

_____d. Place steeples 2′ apart on remainder of pole

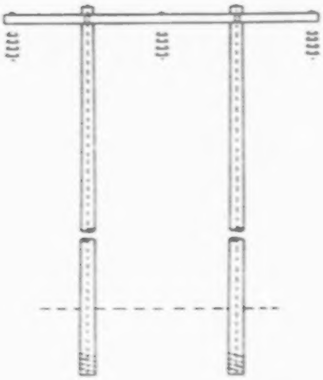
_____e. String and steeple pole ground to pole

TEST

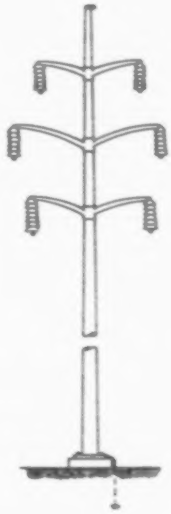
_____f. Place steeples 6″ apart from ground level to 8′ above ground and 8′ from top of pole

_____g. Install required hardware with square washers and locknuts on all bolts

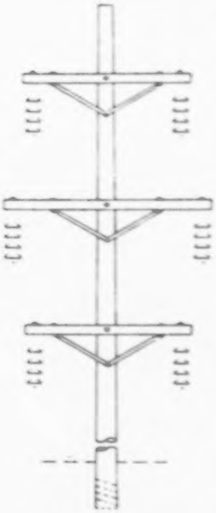
17. Identify the following transmission line structures.



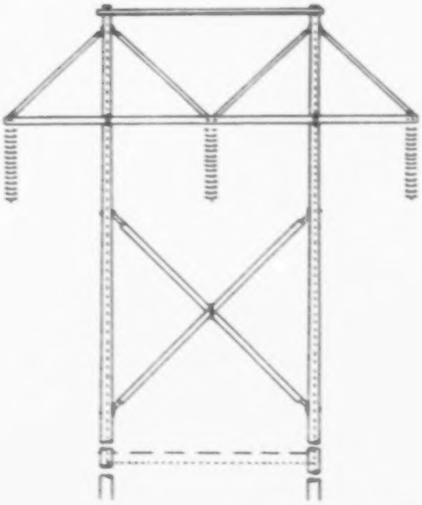
a. ______________________



b. ______________________

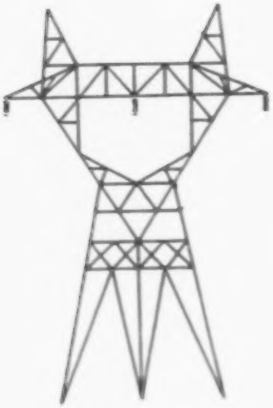


c. ______________________

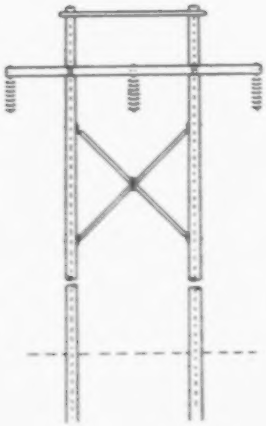


d. ______________________

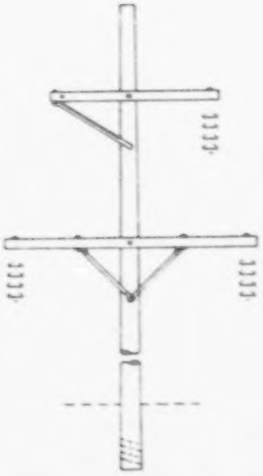
TEST



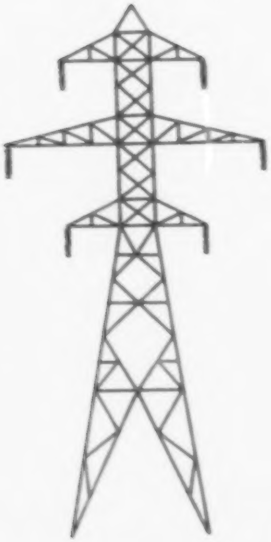
e. ____________________



f. ____________________



g. ____________________



h. ____________________

UNDERGROUND DISTRIBUTION CONSTRUCTION
UNIT 6

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:
   - Provide student with objective sheet.
   - Provide student with information and job sheets.
   - Make transparencies.
   - Discuss unit and specific objectives.
   - Discuss information sheet.
   - Demonstrate and discuss the procedures outlined in the job sheets.
   - Give test.
2. Unit references:
   - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

UNDERGROUND DISTRIBUTION CONSTRUCTION
UNIT 6

ANSWERS TO TEST

1.

a.	5	f.	11	k.	4
b.	7	g.	1	l.	13
c.	10	h.	8	m.	15
d.	12	i.	3	n.	6
e.	9	j.	2	o.	14

2. a. Equipment trailer
   b. Medium-sized trencher with cable plow attached
   c. Large track-mounted trencher
   d. Boring machine and boring tools
   e. Small trencher with backfill blade
   f. Large trencher with frost- and rock-cutting teeth
   g. Backhoe attachment
   h. Large cable plow with cable reel attachment

3.

a.	2	f.	7
b.	9	g.	6
c.	3	h.	1
d.	4	i.	10
e.	5	j.	8

4. (NOTE: Any two of the following are acceptable.)
   a. All work should be done in a thorough and skillful manner
   b. All work should be done in accordance with plans and specifications
   c. All work should meet or exceed the National Electrical Safety Code requirements

ANSWERS TO TEST

5. a. 3 d. 5

   b. 6 e. 2

   c. 4 f. 1

6. (NOTE: Any three of the following are acceptable.)

   a. Handle carefully to avoid damage

   b. Avoid excessive bending

   c. Keep ends of cable sealed against moisture

   d. Do not drag cable

7. a, c, d, e

8. (NOTE: Any two of the following are acceptable.)

   a. Above-grade stake driven near ditch with name of utility attached

   b. Plate inscribed with utility name placed over cable and flush with ground

   c. Electronic voltage detector if cable is energized

   d. Plastic tape inscribed with Caution: Electric Power Cable Below buried near surface of ditch

   e. Spray paint marker

9. In any order:

   a. Lightning arrester

   b. Fuse cut-out

   c. Terminator and bracket

   d. Eye bolt

   e. Shackle

   f. Wire sock

   g. Grounding bushing

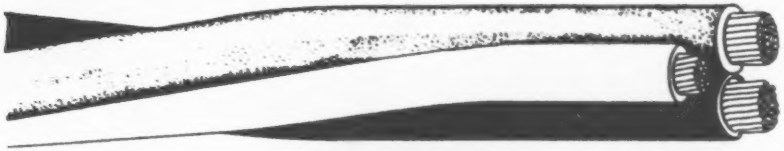
   h. Riser

10. All neutral conductors and groundable parts shall be interconnected

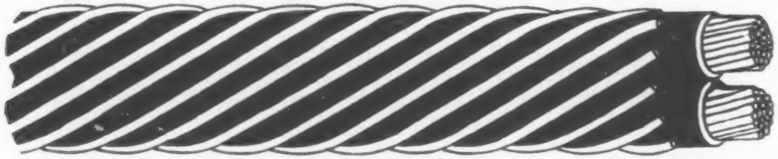
ANSWERS TO TEST

11. a. Loop feed system
    - b. Equipment that has not been properly grounded
    - c. Regenerated charge that can exist on high voltage ungrounded cable
    - d. Other utilities
12. a. Ground the cable being repaired
    - b. Use portable cover or shelter
    - c. Keep material and cable dry
    - d. Keep hands, material, and cable clean
    - e. Clean surfaces with denatured alcohol
    - f. Lubricate contacting surfaces with silicone grease
    - g. Follow manufacturer's specifications
13. a, b, c, e, g
14. Evaluated on Job Sheet 1.
15. Evaluated on Job Sheet 2.

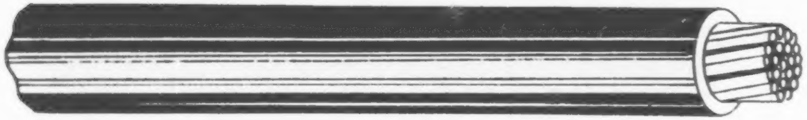
Secondary and Service Cable



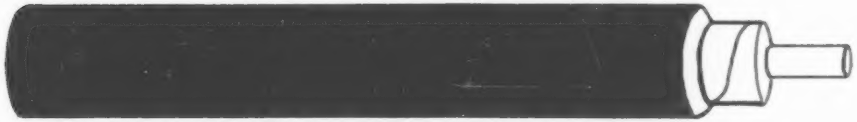
Triplexed



Parallel



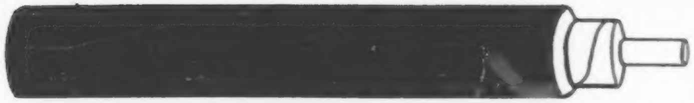
Single Conductor



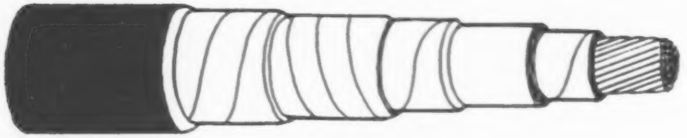
Solid

BEST COPY AVAILABLE

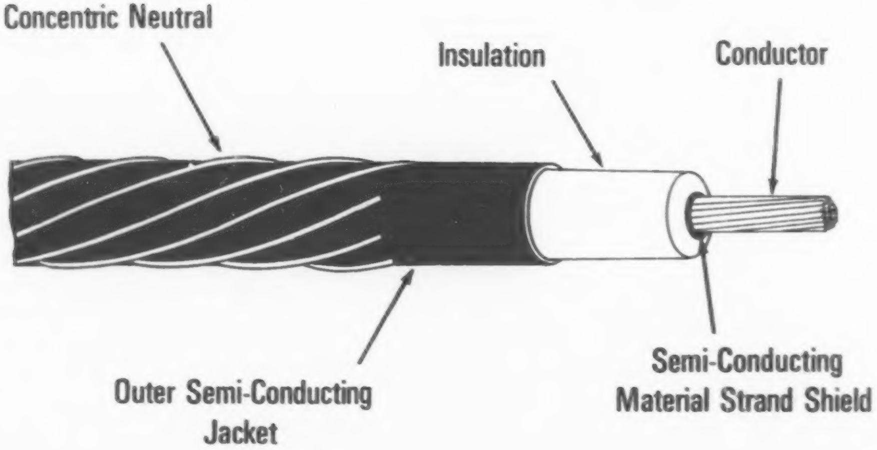
Primary Cable



Solid



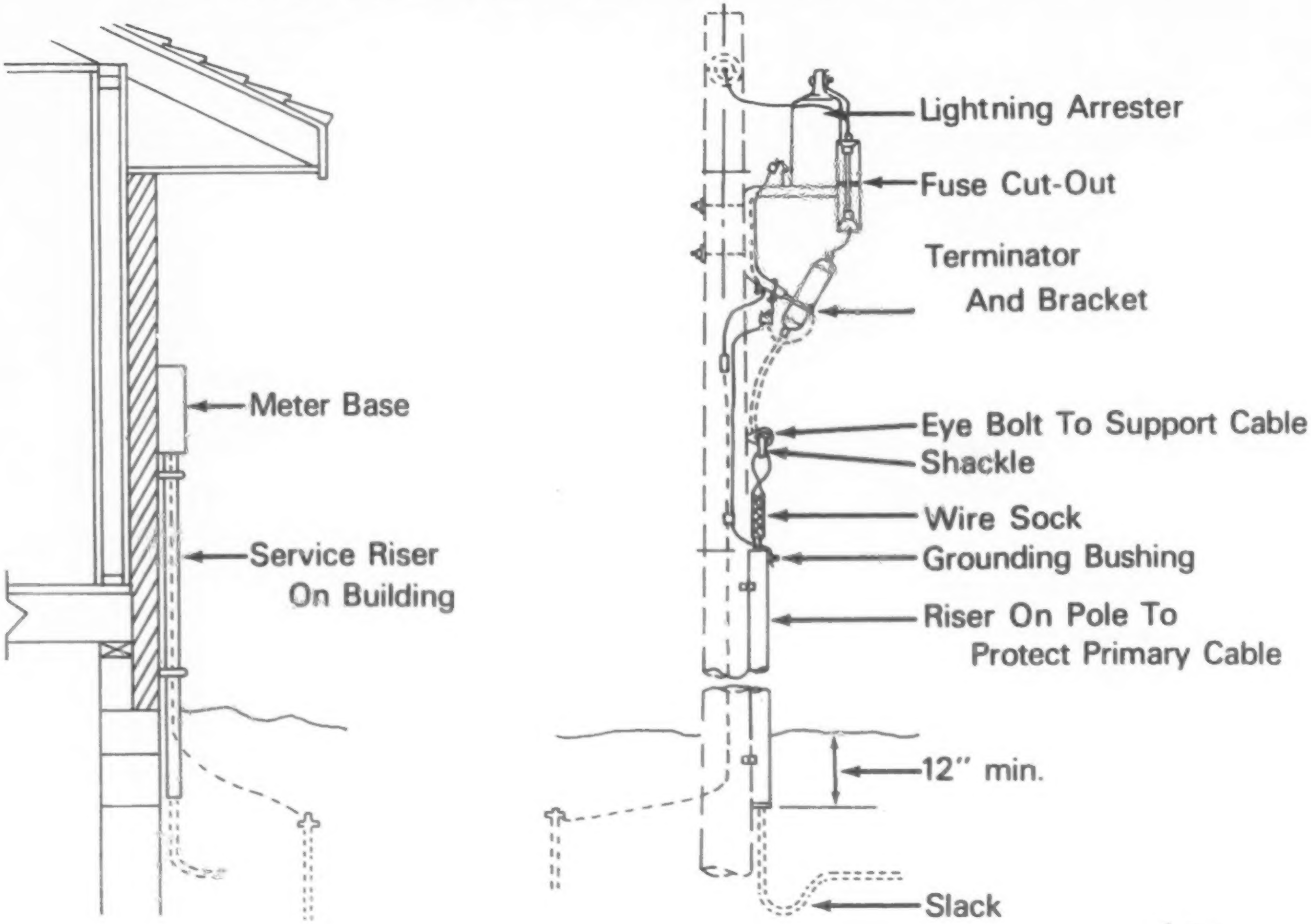
Jacketed
(Shielded)


Concentric Neutral
Insulation
Conductor
Outer Semi-Conducting Jacket
Semi-Conducting Material Strand Shield

May be photocopied for student use.

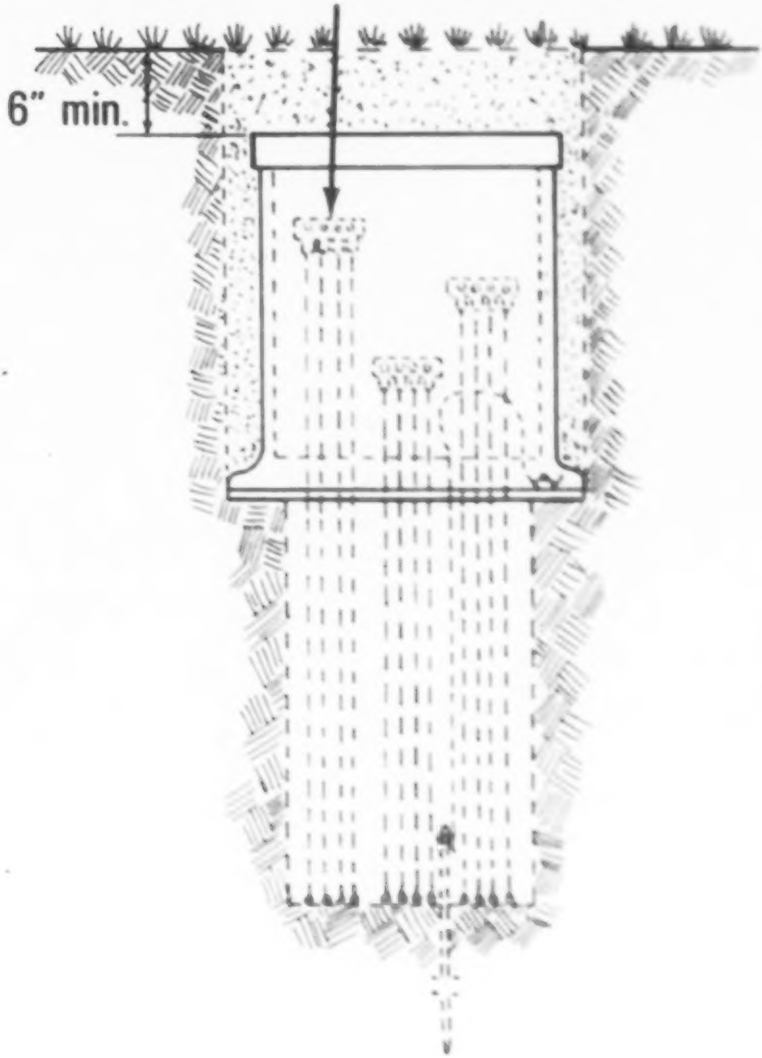
Risers

Risers On Building And Pole Shown With Arrester, Fuse And Terminator



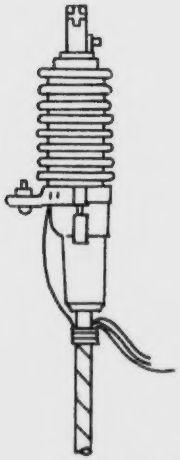
Lightning Arrester
Fuse Cut-Out
Terminator And Bracket
Meter Base
Eye Bolt To Support Cable
Shackle
Wire Sock
Grounding Bushing
Service Riser On Building
Riser On Pole To Protect Primary Cable
12" min.
Slack

Connector Blocks Installed In Pedestal

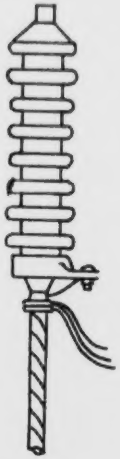


Insulated Connector Blocks
Required for All Terminals

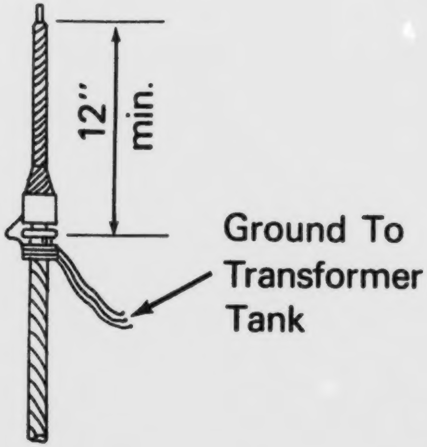
Terminators



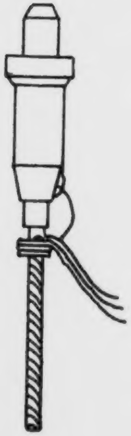
Porcelain



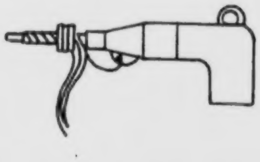
Synthetic Rubber


12" min.
Ground To Transformer Tank

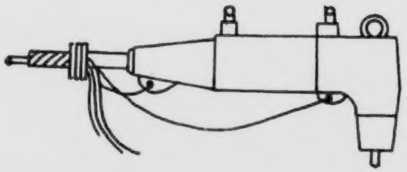
Indoor Type



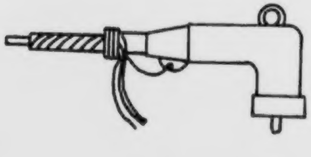
Cable Lead Termination



Non-Load Break Elbow Termination



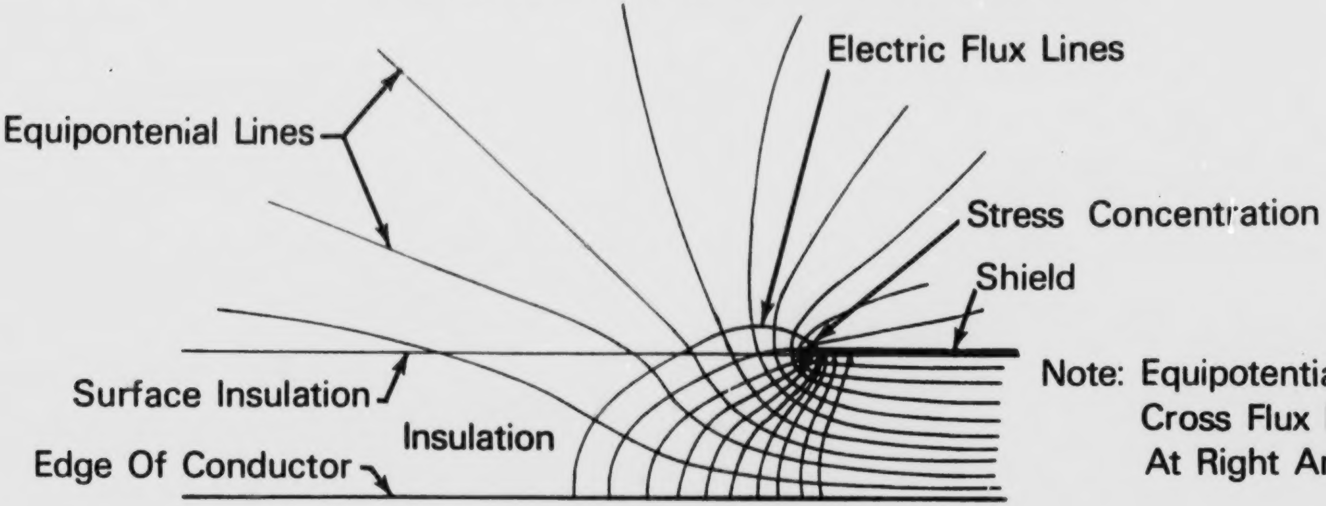
Fused Elbow Termination



Load Break Elbow Termination

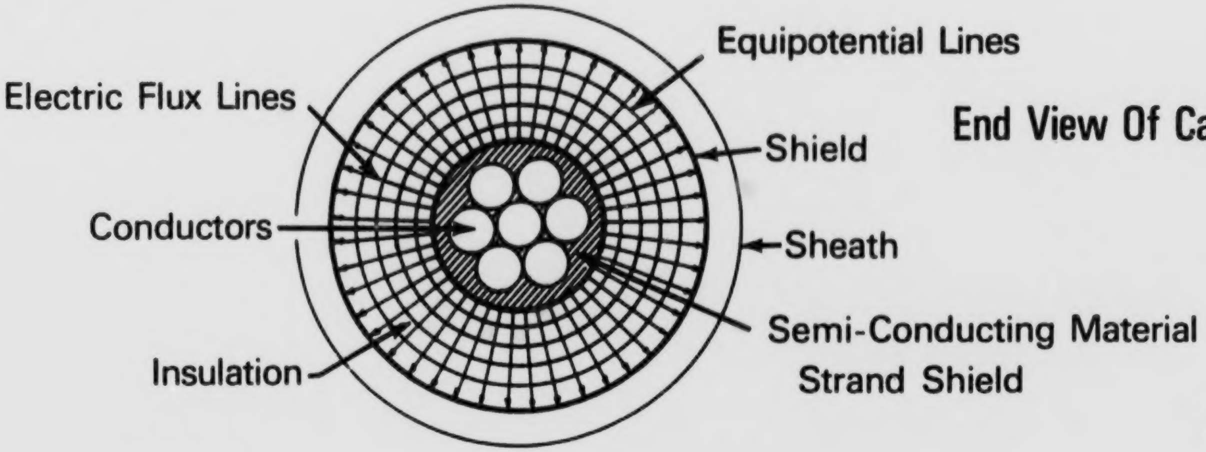
Stress

Cut-Away Section Of Cable Without Stress Relief


Electric Flux Lines
Equipontenial Lines
Stress Concentration
Shield
Surface Insulation
Insulation
Edge Of Conductor

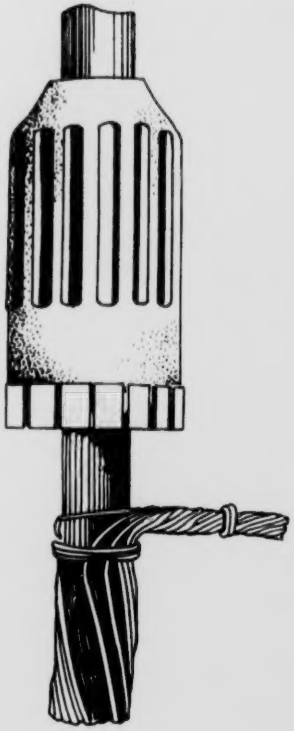
Note: Equipotential Lines
Cross Flux Lines
At Right Angles

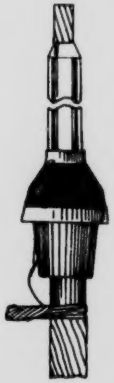
End View Of Cable

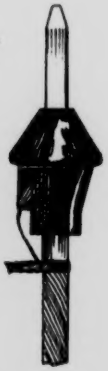

Equipotential Lines
Electric Flux Lines
Shield
Conductors
Sheath
Insulation
Semi-Conducting Material
Strand Shield

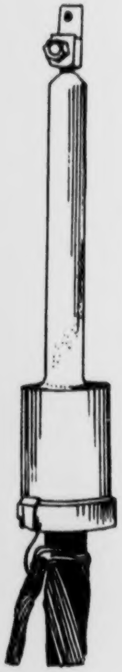
Preformed Slip-On Stress Cones

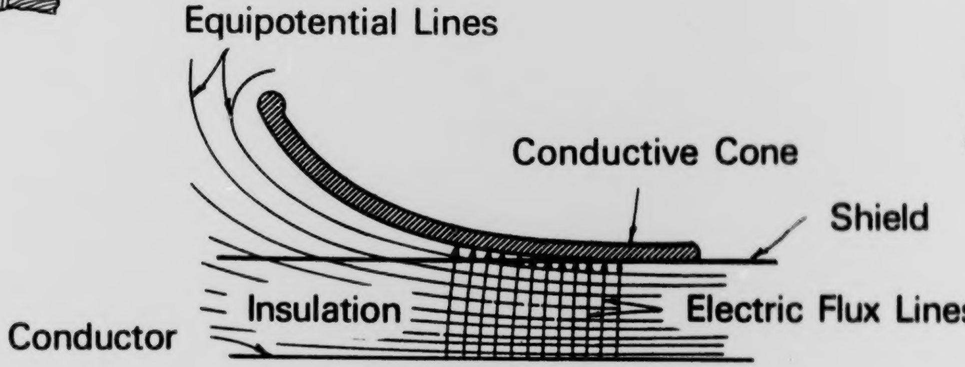
(Indoor Type)



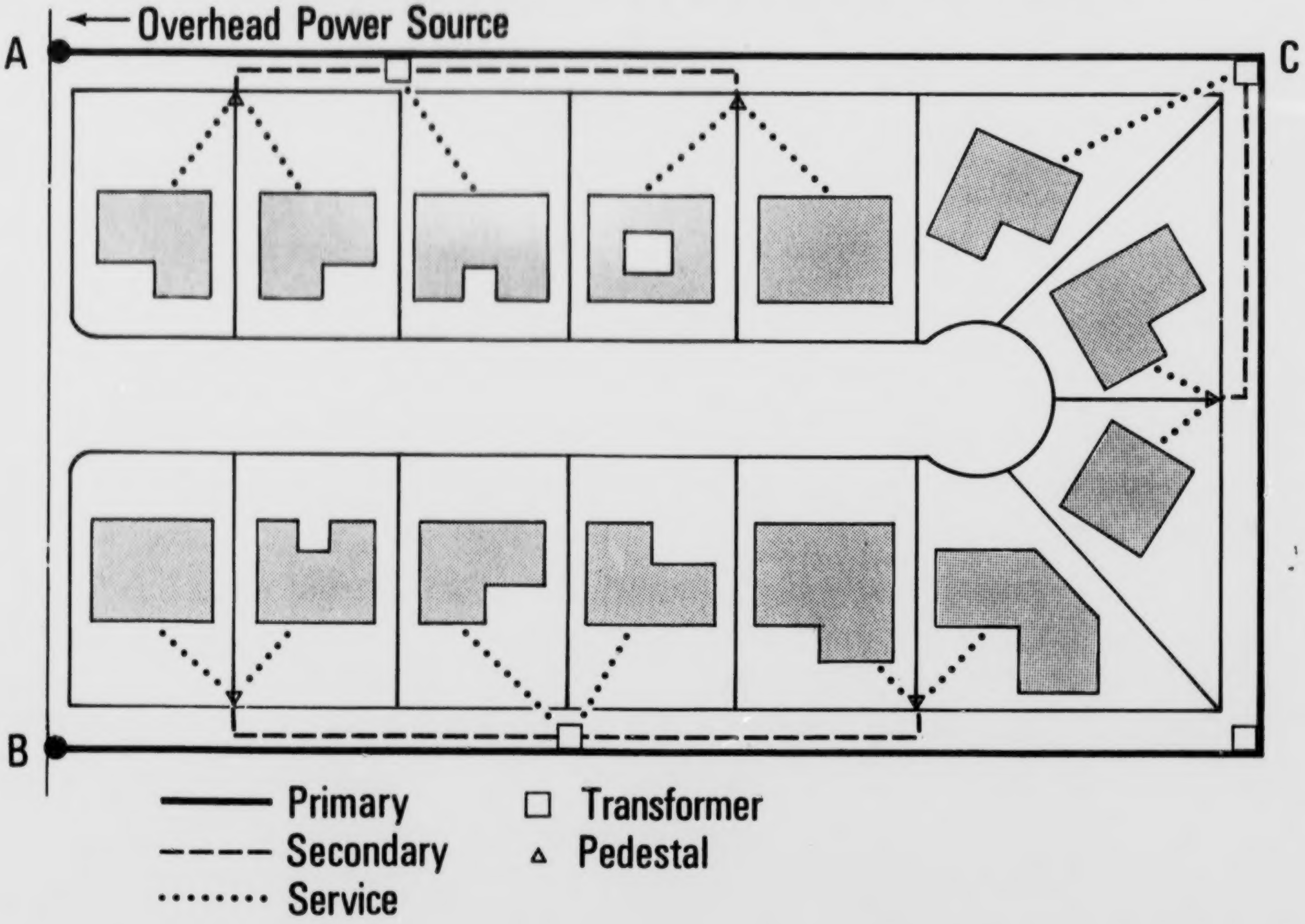






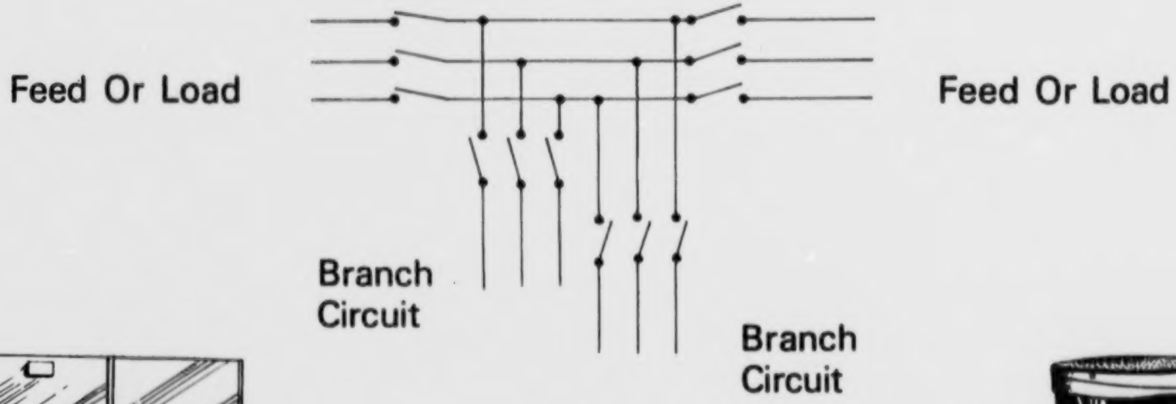

Equipotential Lines
Conductive Cone
Shield
Insulation
Electric Flux Lines
Conductor

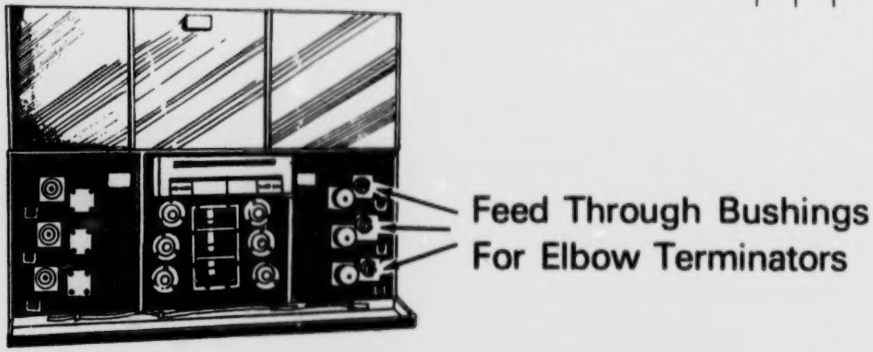
Underground Distribution System


Overhead Power Source
A
B
C
Primary
Secondary
Service
Transformer
Pedestal

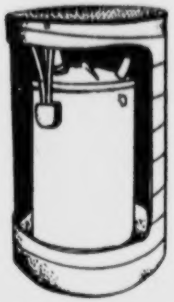
Power may be fed from point "A" or "B" or both. If fed from both points, line will be open at point "C".

Switching Cabinet and Vault


Feed Or Load
Feed Or Load
Branch Circuit
Branch Circuit


Feed Through Bushings For Elbow Terminators

Switching Cabinets Are Constructed For Specific Needs. This Cabinet Shows The Capability Of Two Three-Phase Feeds And Two Three-Phase Branch Circuits.



Cut-Away View Of Fiber Vault Showing Submersible Transformer Installed

UNDERGROUND DISTRIBUTION CONSTRUCTION
UNIT 6

TEST

NAME ______________________________ SCORE ____________

1. Match the terms on the right to the correct definitions. (Definitions are continued on the following page.)

_____a. Length of conduit installed on a pole or a building to protect underground cable above the ground

_____b. Unit installed on the ends of primary cable

_____c. Cone or tape designed to disperse electric flux lines

_____d. Area of housing or business fed by underground power lines

_____e. Electric flux lines which concentrate at the ends of high voltage cable and deteriorate cable insulation

_____f. Solid material that has electrical characteristics between that of a conductor and an insulator and is used for stress control

_____g. Underground cable which runs from transformer or pedestal to metering point

_____h. Conductor spiraled around insulated conductor or conductors in both high and low voltage cable

_____i. High voltage cable which runs from source of power to transformer or protective equipment

_____j. Heavy underground cable which runs from transformer to pedestal

_____k. Buried or partially buried enclosure used as a point of connection for secondary and service cable

1. Service cable
2. Secondary cable
3. Primary cable
4. Pedestal
5. Riser
6. Connector block
7. Terminator
8. Concentric neutral
9. Stress
10. Stress cone
11. Semi-conductor
12. Underground distribution system
13. Feed-through bushing
14. Vault
15. Switching cabinet

TEST

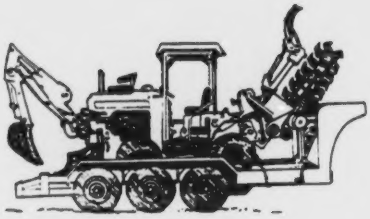
_____l. Bushing used on transformers and switching gear for connecting elbow terminators

_____m. Metal enclosure which contains equipment for changing circuit feeds or loads from one circuit to another

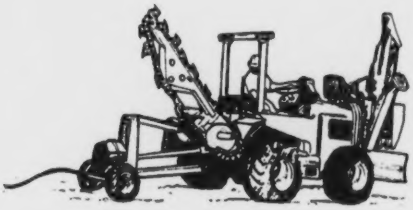
_____n. Aluminum or copper block used to connect conductors

_____o. Fiber or concrete enclosure installed below grade to house transformer or switching gear

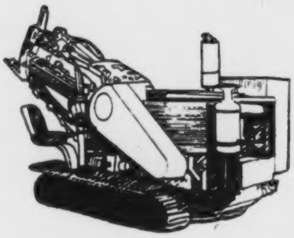
2. Identify the following equipment used in underground construction.



a. ______________________

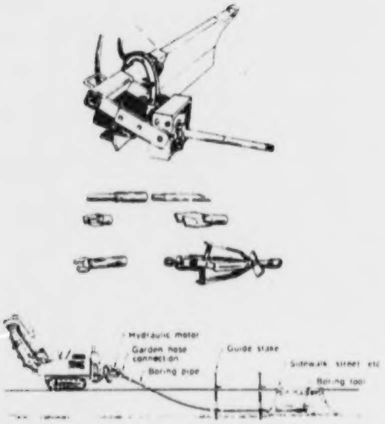


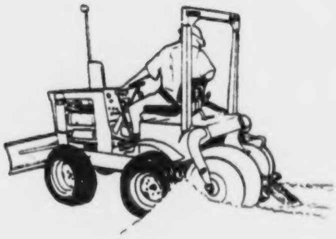
b. ______________________



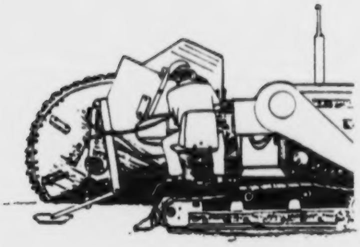
c. ______________________

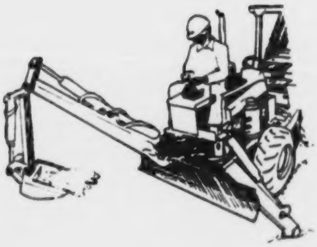
TEST


Hydraulic motor
Garden hose connection
Boring pipe
Guide stake
Sidewalk, street, etc.
Boring tool

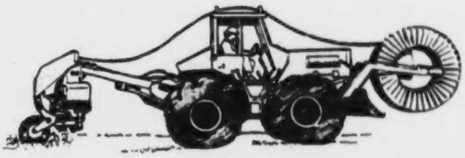


d. ______________________ e. ______________________





f. ______________________ g. ______________________



h. ______________________

TEST

3. Match the equipment on the right to the correct use.

_____a. Transports equipment to and from job sites

_____b. Pushes large diameter pipe under streets and paved areas

_____c. Plows in cable at great depth in open country where pipelines or other underground utilities are not present

_____d. Trenches in frozen ground and in rocky structures

_____e. Trenches and backfills on short cable runs where great depth is not needed

_____f. Trenches in muddy or sandy areas where long cable runs are needed

_____g. Dips out large areas for working room

_____h. Breaks up concrete or hard rock

_____i. Bores and reams out holes under streets and paved areas

_____j. Plows in cable where great depth is not needed or trenches when greater depth is necessary

1. Hydraulic jackhammer
2. Equipment trailer
3. Large cable plow with cable reel attachment
4. Larger trencher with frost- and rock-cutting teeth
5. Small trencher with backfill blade
6. Backhoe attachment
7. Large track mounted trencher
8. Medium-sized trencher with cable plow
9. Hydraulic pipe pusher
10. Boring machine and boring tools

4. List two general requirements for underground construction.

a. ______________________________________

b. ______________________________________

TEST

5. Arrange in order the correct procedure for installing cable. Place a "1" before the first step, a "2" before the second step, and so on.

_____a. Inspect cable as it is removed from reel

_____b. Backfill

_____c. Remove any objects from trench that might damage cable

_____d. Lay cable in trench by hand

_____e. Lay out cable from moving vehicle

_____f. Lay conduit under streets

6. List three precautions to observe when handling underground cable.

a. ____

b. ____

c. ____

7. Select from the following list methods of marking cable for identification.

_____a. Colored plastic tape

_____b. Paper tags

_____c. Embossed plastic tape

_____d. Corrosion-resistant metal tags

_____e. Imprinted plastic tags

8. List two methods used to locate and identify a utility ditch.

a. ____

b. ____

TEST

9. Identify equipment used to terminate primary cable on a pole.

a. ______________________ e. ______________________

b. ______________________ f. ______________________

c. ______________________ g. ______________________

d. ______________________ h. ______________________

10. State the requirement for grounding underground equipment.

____

____

11. List four hazards which may be encountered in underground construction.

a. ____

b. ____

c. ____

d. ____

12. List seven precautions to observe when splicing or terminating cable.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ____

TEST

13. Select from the list below the tools used in underground construction.

_____a. Trench cleaning spoon

_____b. Cable cutters

_____c. Insulation removing tool

_____d. Chain hoist

_____e. Hand shovel

_____f. Guy grip

_____g. Compression tool

14. Evaluated on Job Sheet 1.

15. Evaluated on Job Sheet 2.

PERSONAL CLIMBING TOOLS AND EQUIPMENT
UNIT 7

SUGGESTED ACTIVITIES

1. Suggested activities for the instructor:

    - Provide student with objective sheet.
    - Provide student with information and job sheets.
    - Make transparency.
    - Discuss unit and specific objectives.
    - Discuss information sheet.
    - Demonstrate and discuss procedure outlined in the job sheet.
    - Give test.

2. Unit references

    - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook*. 7th Ed. New York: McGraw-Hill Book Co., 1986.
    - *Power Line Technician*. Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

PERSONAL CLIMBING TOOLS AND EQUIPMENT
UNIT 7

ANSWERS TO TEST

1. a. 4
   b. 8
   c. 9
   d. 2
   e. 3
   f. 6
   g. 1
   h. 7
   i. 5
   j. 10

2. a. Pad
   b. Strap
   c. Safety strap
   d. Body belt with D-rings
   e. Gaff gauge
   f. Climber
   g. Gaff guard

3. a. 3
   b. 2
   c. 1

4. (NOTE: Any two of the following under each category are acceptable.)
   a. Body belt
      1) Loose stitching
      2) Loose rivets
      3) Cracks in leather
      4) Hard or brittle spots in leather
      5) Cuts or tears in leather

ANSWERS TO TEST

b. Safety strap
  1) Worn spots
  2) Enlarged buckle holes
  3) Cuts or tears
  4) Distorted snaps
  5) Crack in snaps
  6) Weak springs in snaps
  7) Loose rivets
  8) Stitching

c. Climber
  1) Worn straps
  2) Crack in metal
  3) Worn area of footpiece

d. Gaff
  1) Length
  2) Width
  3) Thickness
  4) Shape

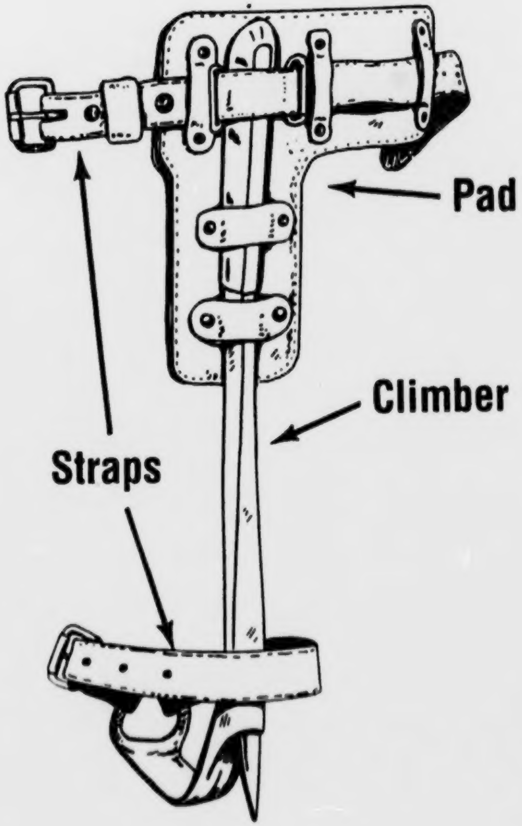
5. a. Body belt and leather equipment
  1) Clean leather with natural soap (castile)
  2) Dress leather with saddle soap and good leather dressing

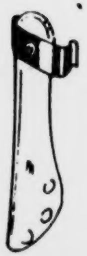
b. Gaff
  1) Check with gaff gauge frequently
  2) File underside and sides to shape and sharpen

ANSWERS TO TEST

6. (NOTE: Any five of the following are acceptable.)
    a. Avoid cracks, knots, and bird holes
    b. Avoid wires, steeples, and hardware
    c. Avoid using braces or hardware to climb
    d. Set both climbers securely when safetying off
    e. Check safety snap visually to see that it is secured in D-ring
    f. Do not safety off above top crossarm on distribution line
    g. Do not safety off on pole-top pins or other hardware
    h. Do not snap both ends of safety strap in one D-ring when safetying off on a structure
7. a,b,c,d,e,g,h,i,j,k,l,m
8. a. Leather goods
        1) Store away from heat source
        2) Do not store with sharp-edged objects
        3) Store in proper area
    b. Climbers—Store with gaff guards on gaffs
9. Evaluated on Job Sheet 1.

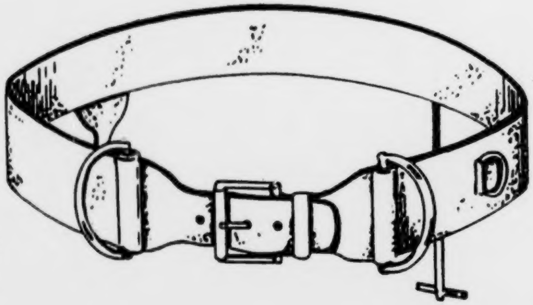
Personal Climbing Tools and Equipment


Pad
Climber
Straps

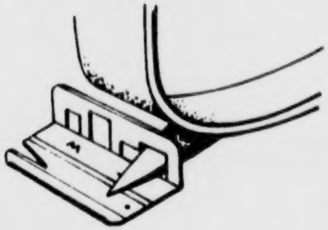


Gaff guard

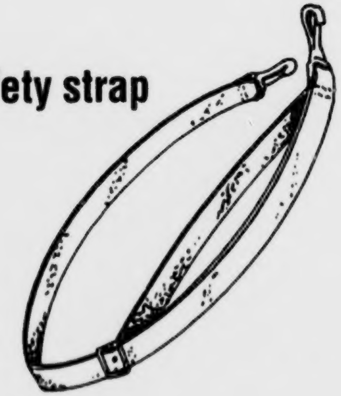
Body belt with D-rings



Gaff gauge



Safety strap



PERSONAL CLIMBING TOOLS AND EQUIPMENT
UNIT 7

TEST

NAME ______________________________ SCORE __________

1. Match the terms on the right to the correct definitions.

_____a. Belt which is fitted to hip measurement and used to carry hand tools while working on above-ground structures

_____b. Strap used to secure a line technician while working on a structure

_____c. L-shaped steel or aluminum strap used to climb wood structures

_____d. Leather or nylon band with attached buckle used to secure climber to line technician's leg

_____e. Leather or nylon cushion used to protect line technician's leg

_____f. Metal spur attached to the inside of climber

_____g. Tested metal ring attached to either end of body belt

_____h. Tested metal hook with a spring-loaded safety catch which is attached to either end of safety strap

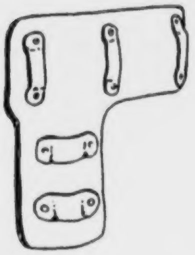
_____i. Measuring tool used to determine correct length, width, thickness, and shape of gaff

_____j. Correct file and handle, gauge, finishing stone, and instructions to keep gaffs in operational condition

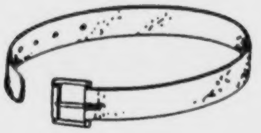
1. D-ring
2. Strap
3. Pad
4. Body belt
5. Gaff gauge
6. Gaff
7. Snap
8. Safety strap
9. Climber
10. Gaff gauge kit

TEST

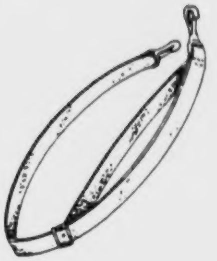
2. Identify the following personal climbing tools and equipment.



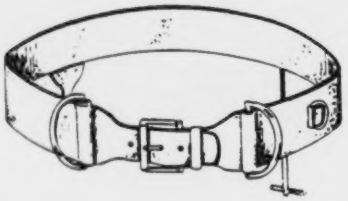
a. ________________



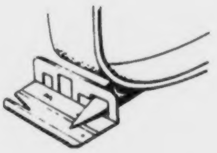
b. ________________



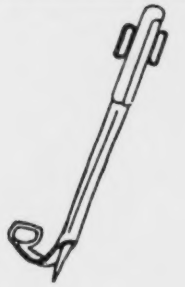
c. ________________



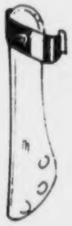
d. ________________



e. ________________



f. ________________



g. ________________

3. Match the tools and equipment on the right to the specific use.

_____a. Assists line technician in climbing wood structure; assists line technician to maintain position on wood structure

_____b. Holds tools; holds line technician while working on a structure

_____c. Supports weight of line technician and equipment

1. Safety strap
2. Body belt
3. Climbers, straps and pads

TEST

4. List two conditions to watch for when inspecting each of the following personal climbing tools and equipment.

   a. Body belt

      1) ____________________

      2) ____________________

   b. Safety strap

      1) ____________________

      2) ____________________

   c. Climber

      1) ____________________

      2) ____________________

   d. Gaff

      1) ____________________

      2) ____________________

5. Name two items of maintenance for each of the following types of tools and equipment.

   a. Body belt and leather equipment

      1) ____________________

      2) ____________________

   b. Gaff

      1) ____________________

      2) ____________________

TEST

6. List five safety precautions to observe when climbing poles.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

7. Select from the following list those statements which are part of the general procedure for climbing poles. Place an "X" in the blanks provided.

_____a. Inspect pole for unsafe conditions

_____b. Remove rocks and other objects from base of pole

_____c. Wear gloves and long sleeves for protection of hands and arms

_____d. Step onto pole with gaff point directed toward center of pole

_____e. Keep gaffs properly shaped and sharp

_____f. Wear thin-soled shoes to feel position of climbers

_____g. Keep knees, hips, and shoulders away from pole

_____h. Take short steps (6 to 8 inches)

_____i. Remove gaff from pole by swinging knee away from pole with a breaking away motion

_____j. Use hands and arms for balance only

_____k. Climb with the legs

_____l. Wear body belt and safety strap when climbing

_____m. Take hand line up ole

TEST

8. Name three rules for storage of leather goods and one rule for storage of climbers.

   a. Leather goods

      1) ______________________________

      2) ______________________________

      3) ______________________________

   b. Climbers—______________________________

9. Evaluated on Job Sheet 1.

RIGHT-OF-WAY
UNIT 8

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

    - Provide student with objective sheet.
    - Provide student with information and assignment sheets.
    - Discuss unit and specific objectives.
    - Discuss information and assignment sheets.
    - Give test.

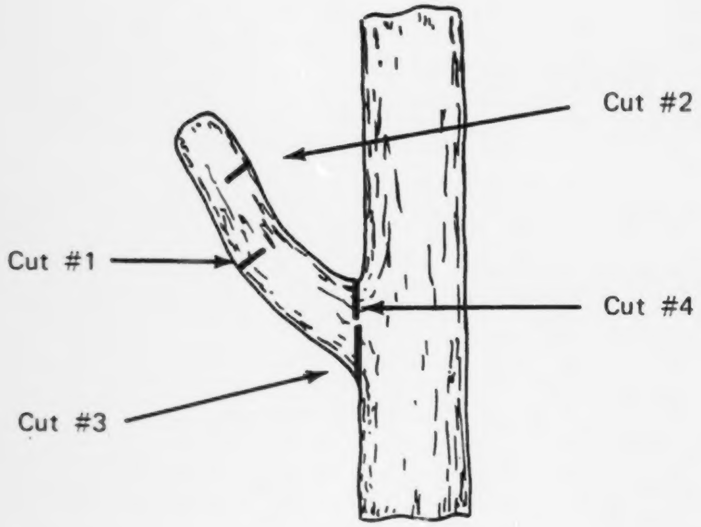
2. Unit references

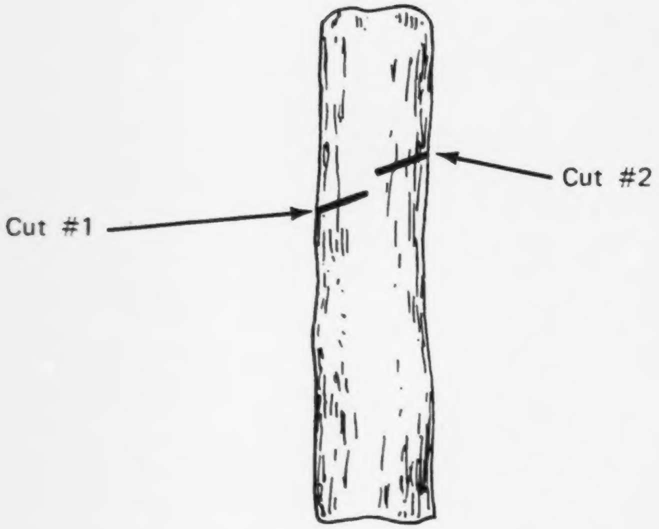
    - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook*. 7th ed. New York: McGraw-Hill Book Co., 1986.
    - *Power Line Technician*. Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

RIGHT-OF-WAY
UNIT 8

ANSWERS TO ASSIGNMENT SHEETS

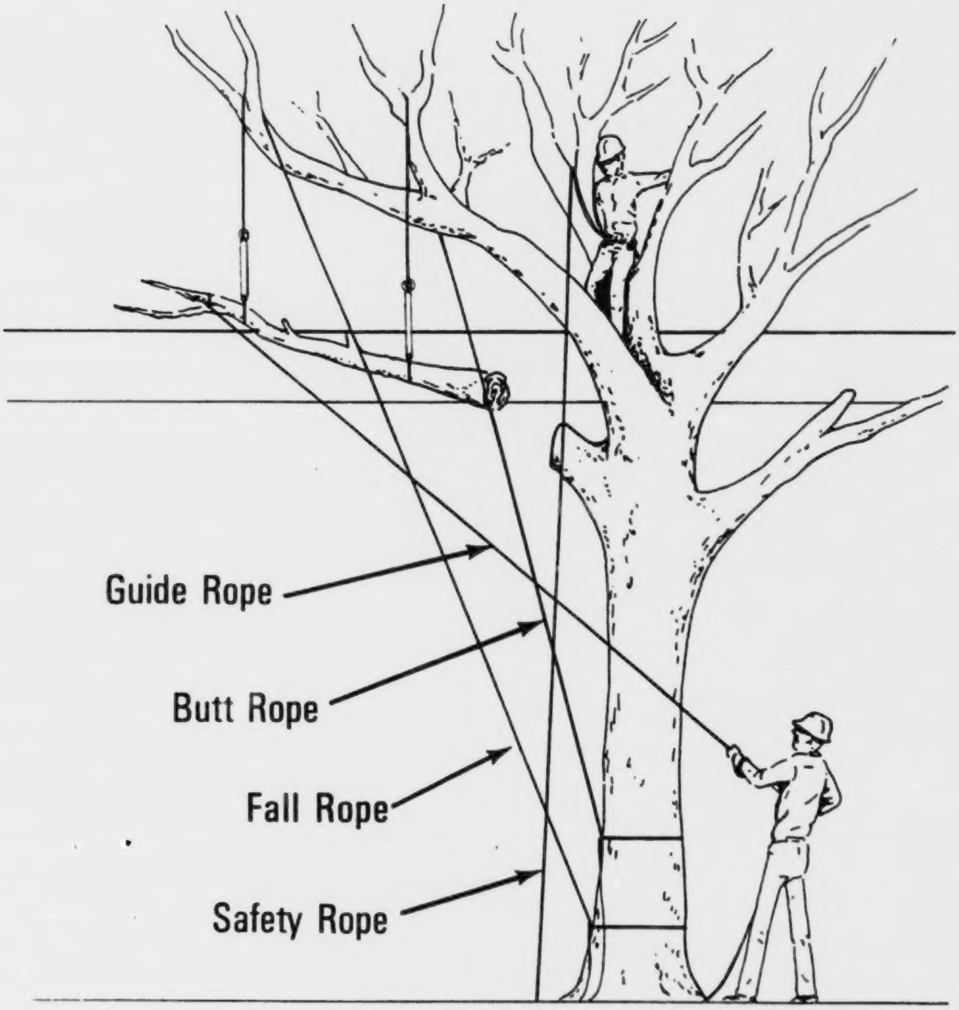
Assignment Sheet 1


Cut #2
Cut #1
Cut #4
Cut #3



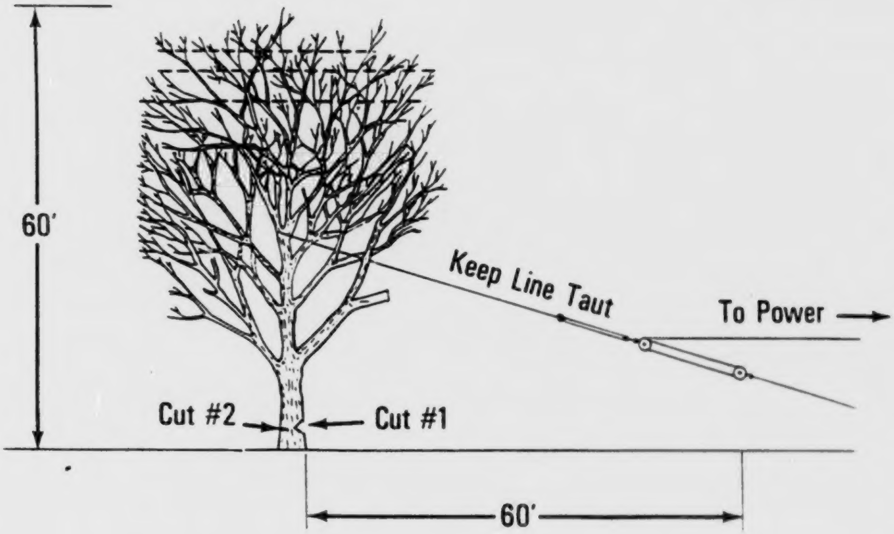
ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 2


Guide Rope
Butt Rope
Fall Rope
Safety Rope

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet 3


60'
Keep Line Taut
To Power
Cut #2
Cut #1
60'

RIGHT-OF-WAY
UNIT 8

ANSWERS TO TEST

1.
   a. 3
   b. 1
   c. 2
   d. 4
   e. 6
   f. 5
   g. 8
   h. 7

2.
   a. Obtain permission
   b. Be sure owner understands what work is to be done
   c. Dispose of brush by burning, chipping, or hauling away according to landowner's wishes
   d. Respect owner's property rights

3. In any order:
   a. Hand saw
   b. Power saw
   c. Climber's saddle
   d. Pruners
   e. Axe
   f. Long-handled trimmer
   g. Sprayer
   h. Chipper

4.
   a. Prevent electric service outages
   b. Prevent damage to conductors
   c. Reduce power loss
   d. Allow access to electrical system

5. a,b,c,d,e,f,g,h,j,k,l,m,n

6. b,c,d

ANSWERS TO TEST

7. a. Tie butt rope to limb near cut

   b. Tie fall rope near outer end of limb

   c. Tie guide rope at outer end of limb

   d. Extend butt and fall ropes upward and through separate forks in limbs above limb to be removed

   e. Extend guide rope to ground

   f. Use insulated link sticks

   g. Tie butt and fall ropes to tree trunk

   h. Secure climber with safety rope

   i. Cut limb and swing it away from conductor with guide rope

   j. Lower limb with butt and fall rope

8. a. Saw or chop a V-shaped notch 1/4 way through trunk on the side which the tree should fall

   b. Saw through tree from opposite side of notch

   c. Use rope to guide tree in direction needed

9. a. Center of pole line to growth—10 feet

   b. Total width of clearing—20 feet

   c. Minimum distance between conductors and growth—6 feet

10. a. Clearing

    1) Hand-operated equipment

    2) Motorized equipment

    b. Chemical

    (NOTE: Any two of the following are acceptable.)

    1) Hand sprayer

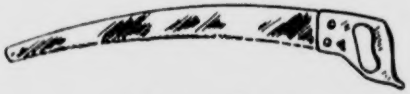
    2) Aerial spraying

    3) Pellet application

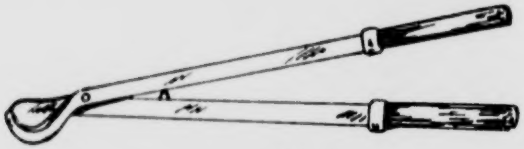
ANSWERS TO TEST

11. a. Black willow
    b. Cottonwood
    c. Honey locust
    d. Box elder
    e. Chinese elm
    f. Catalpa
    g. Black locust
12. a. Poison sumac
    b. Poison oak
    c. Poison ivy
13. Evaluated on Assignment Sheet 1.
14. Evaluated on Assignment Sheet 2.
15. Evaluated on Assignment Sheet 3.

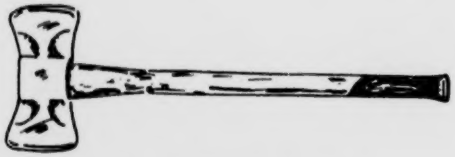
Tools and Equipment For Right-of-Way Clearing and Control



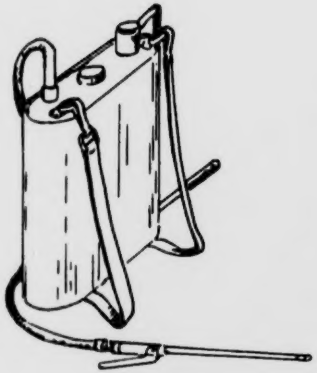
Hand Saw



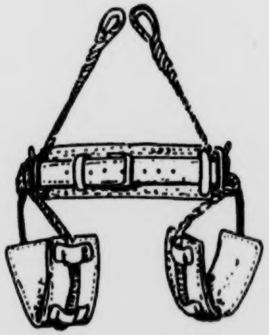
Pruner



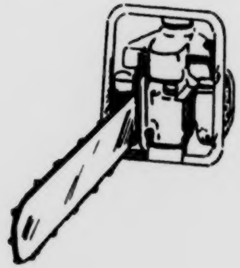
Axe



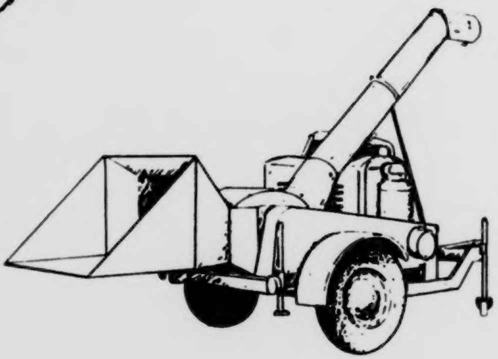
Sprayer



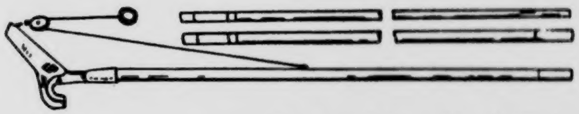
Climber's Saddle



Power Saw



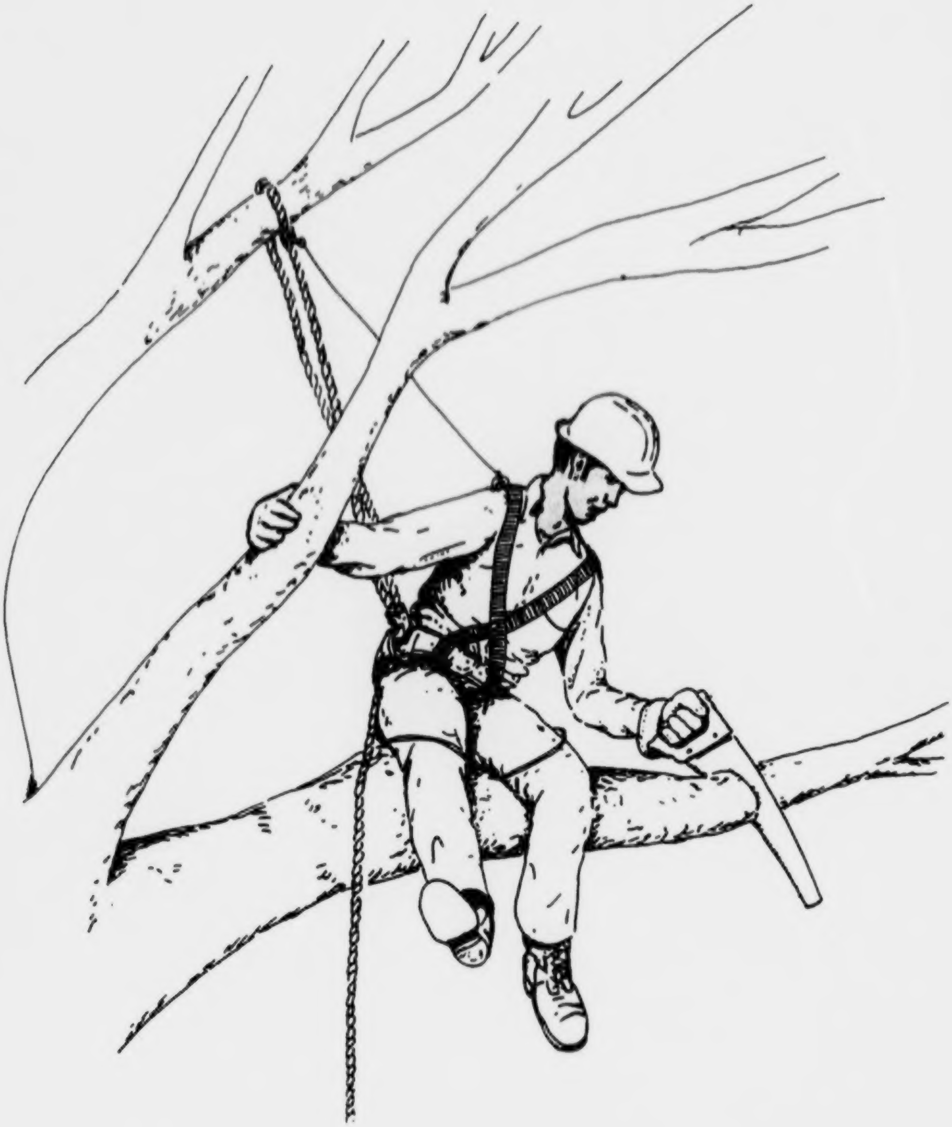
Chipper



Long-Handled Trimmer

May be photocopied for student use.

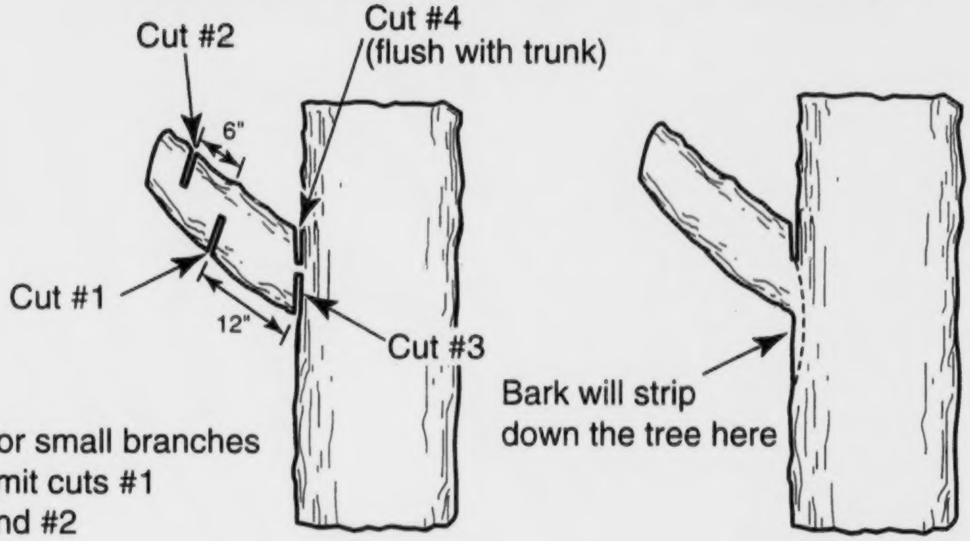
Using Safety Sling While Trimming Tree



TM 2

May be photocopied for student use.

Methods of Tree Trimming

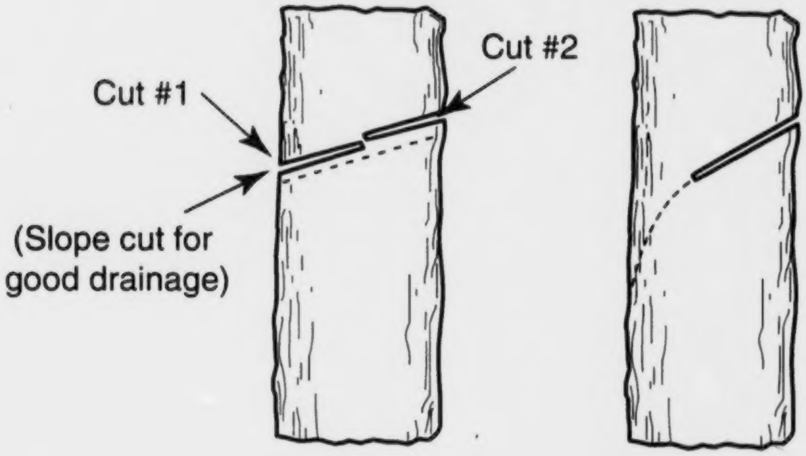

Cut #2
Cut #4
(flush with trunk)
6"
Cut #1
12"
Cut #3
Bark will strip
down the tree here

For small branches
omit cuts #1
and #2

Right

Wrong

Removal of heavy side limb


Cut #1
Cut #2
(Slope cut for
good drainage)

Right

Wrong

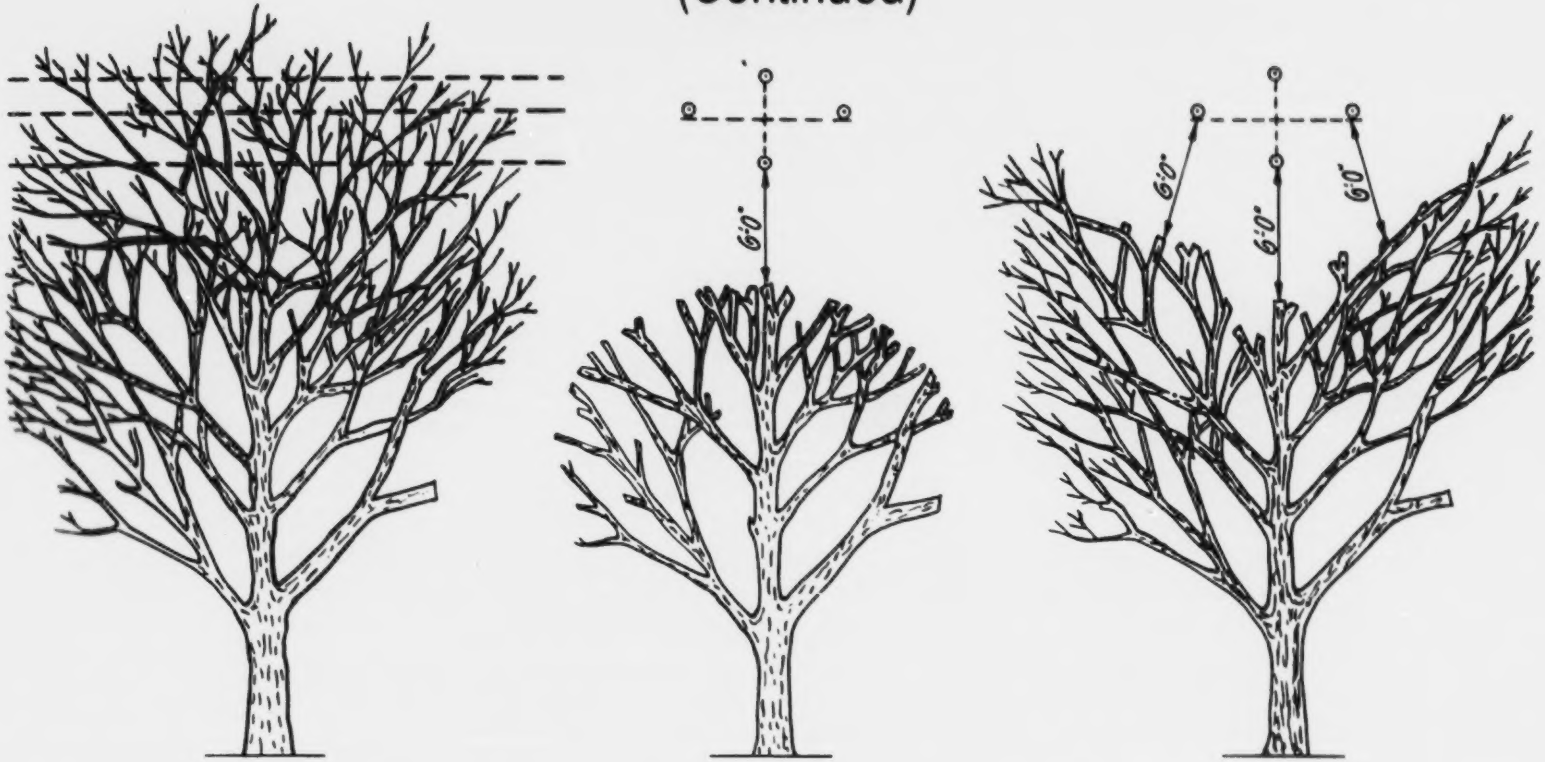
Removal of vertical limb

Note: Coat final cut with tree paint

TM 3

Methods of Tree Trimming

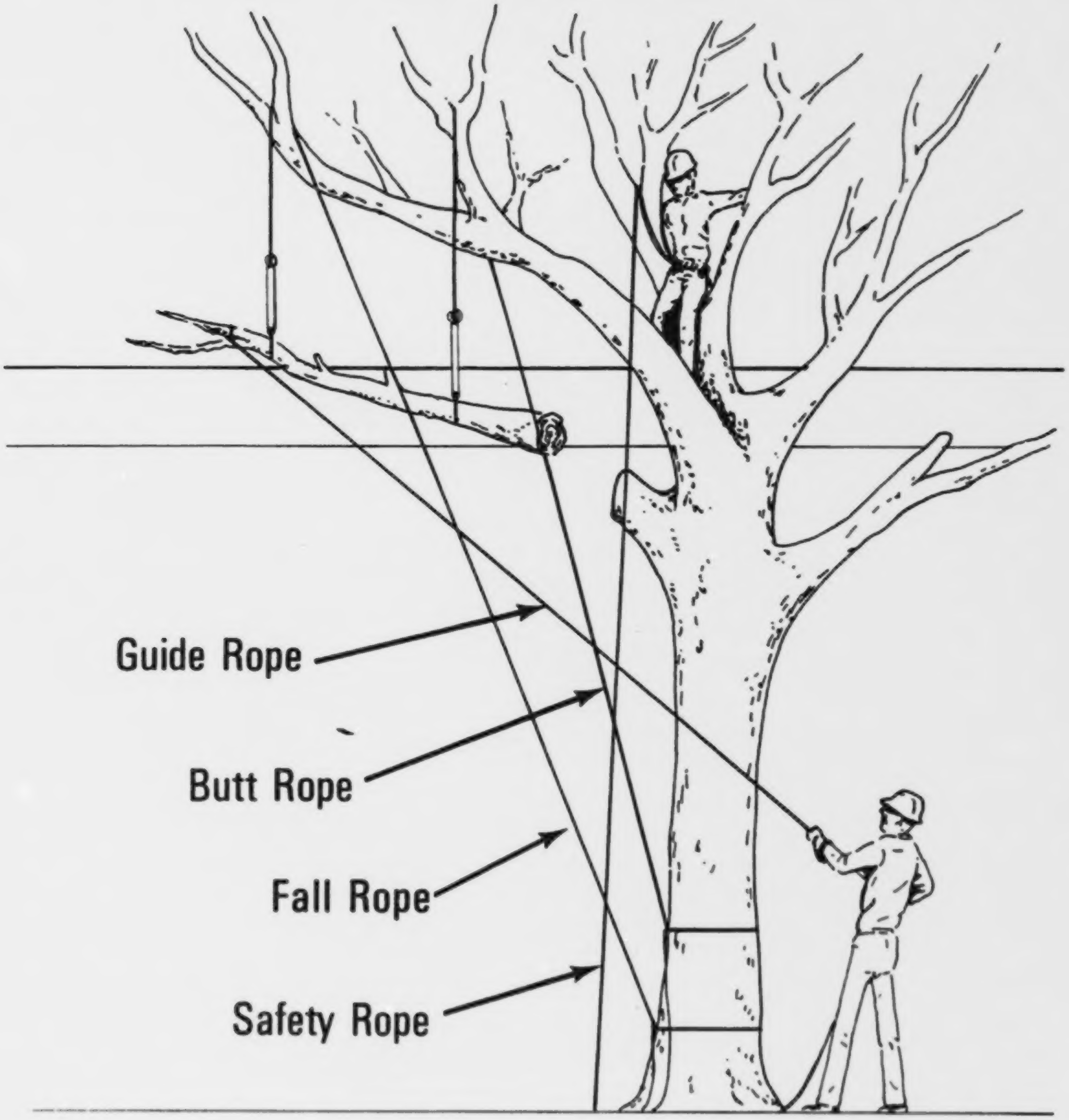
(Continued)



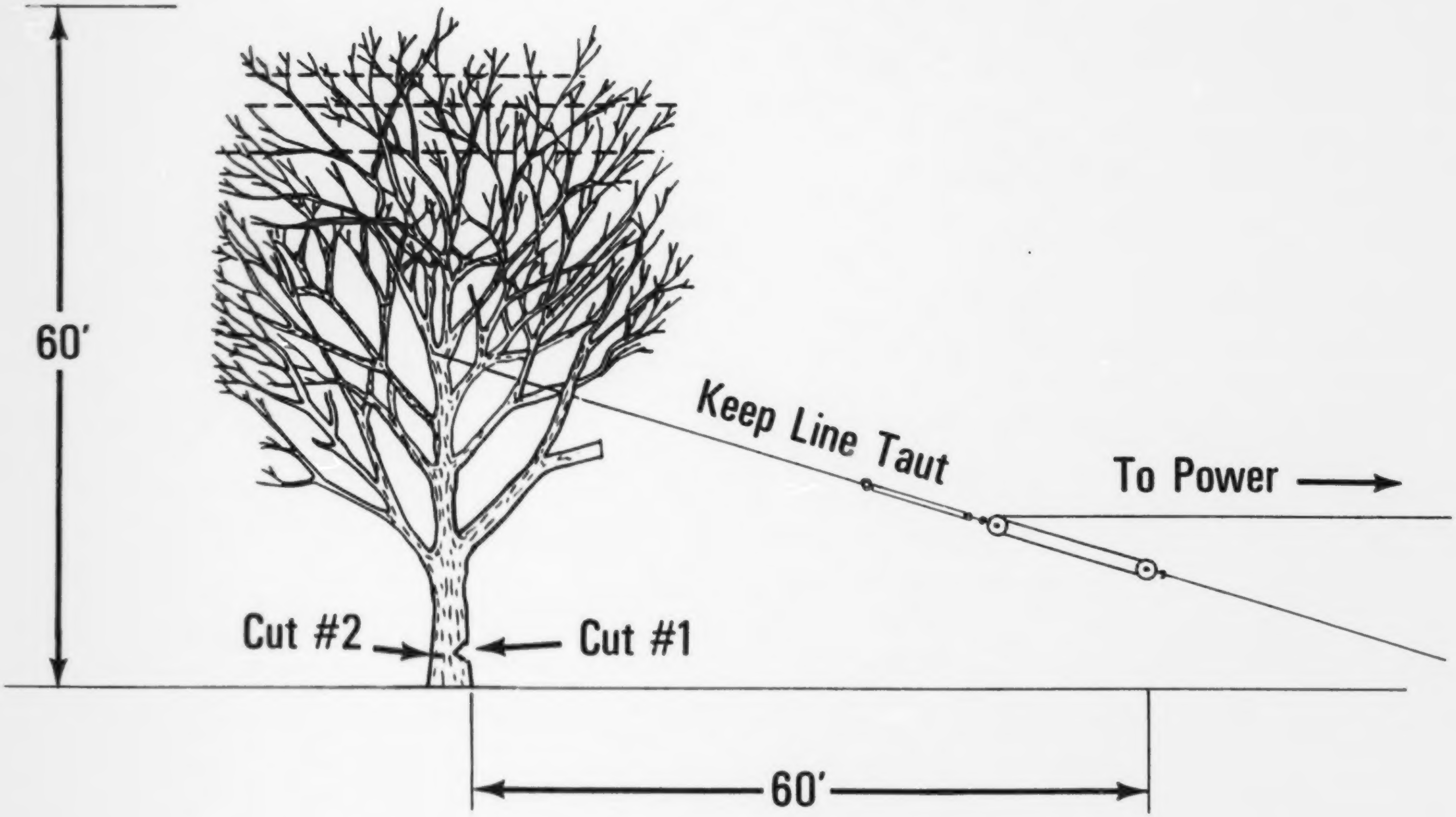
Before Trimming **Right Way** **Wrong Way**

NOTE: No parts of tree should be closer than 6'-0" from open wiring. Trimming should leave tree with symmetrical appearance.

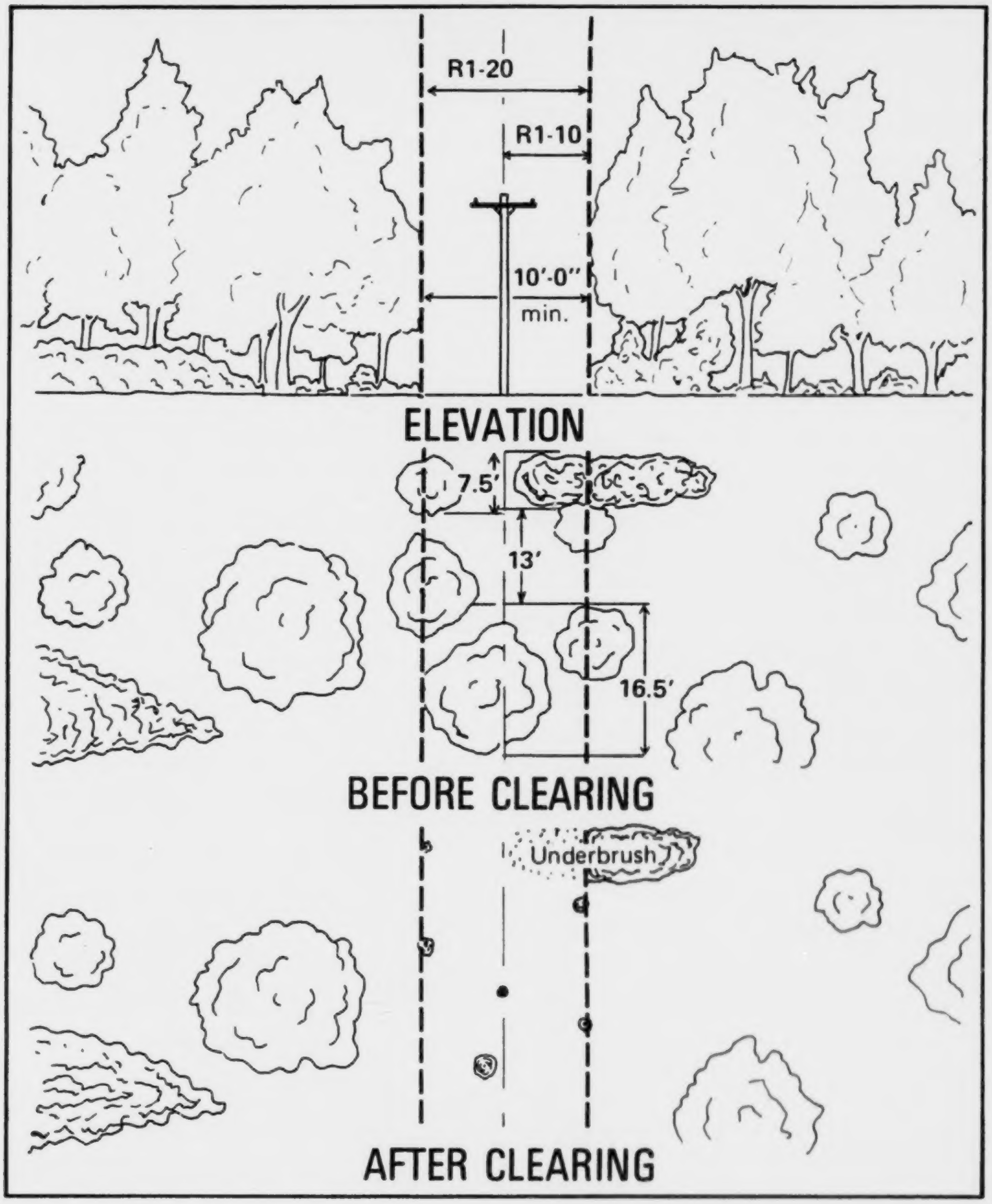
Removing Limb Hanging Over Energized Conductor


Guide Rope
Butt Rope
Fall Rope
Safety Rope

Felling A Tree


60'
Keep Line Taut
To Power
Cut #2
Cut #1
60'

Specifications For Clearing Right-Of-Way For Distribution Line


R1-20
R1-10
10'-0"
min.
ELEVATION
7.5'
13'
16.5'
BEFORE CLEARING
Underbrush
AFTER CLEARING

NOTE: See NESC for clearances.

TM 7

RIGHT-OF-WAY
UNIT 8

TEST

NAME ______________________________ SCORE ____________

1. Match the terms on the right to the correct definitions.

_____a. Restrict or remove new growth from right-of-way

_____b. Rope used to secure climber to tree while removing limbs

_____c. Shrubs, bushes, or small trees growing beneath large trees

_____d. Area on which permission has been obtained to construct power lines

_____e. Removal of trees and shrubs from right-of-way

_____f. Recommended distance which should be maintained between conductors and growth

_____g. Current not metered or sold to the consumers

_____h. Interruption of electric service

1. Safety sling
2. Underbrush
3. Control
4. Right-of-way
5. Clearance
6. Clearing
7. Outage
8. Power loss

2. List four methods to maintain good public relations.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

TEST

3. Identify tools used in right-of-way clearing and control.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________

TEST

4. State the purposes of right-of-way control.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

5. Select from the following list the safe working procedures by placing an "X" in the blanks provided.

   _____a. Check condition of all tools before use

   _____b. Use axes and hatchets for ground level work only

   _____c. Climb into tree with a ladder

   _____d. Rope off or barricade area to protect the public

   _____e. Post Men Working signs when working near streets or highways

   _____f. Wear eye protection

   _____g. Wear rubber gloves and rubber sleeves with protectors when working near energized conductors

   _____h. Use power saw below shoulder level only

   _____i. Climb into all trees with tree climbing tools

   _____j. Park vehicles a safe distance from work area

   _____k. Do not use power saw while working in a tree

   _____l. Keep a separation of at least 10 feet between persons cutting brush

   _____m. Use safety sling while trimming tree

   _____n. Check for overhead power lines

TEST

6. Select the proper methods of tree trimming from the following list by placing an "X" in the blanks provided.

_____a. Start first cut on top side of limb

_____b. Remove limb flush with trunk

_____c. Start second cut on top side of limb

_____d. Slope cut on vertical limbs for good drainage

7. List steps to remove limb hanging over an energized conductor.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

8. List steps to fell a tree.

a. ____________________

____

b. ____________________

c. ____________________

TEST

9. State the specifications for clearing right-of-way for distribution line.

a. ______________________________

b. ______________________________

c. ______________________________

10. List two types of right-of-way control for each of the following methods.

a. Clearing

1) ______________________________

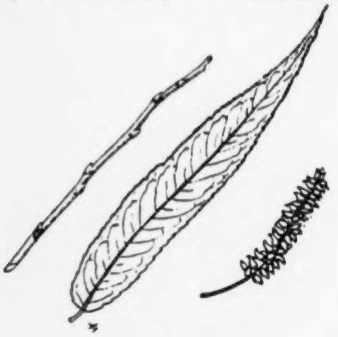
2) ______________________________

b. Chemical

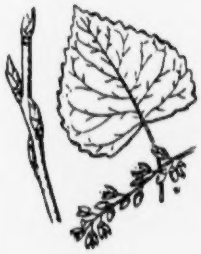
1) ______________________________

2) ______________________________

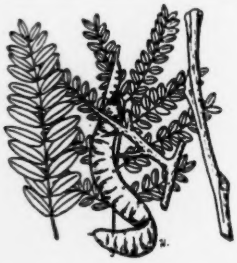
11. Identify the following trees that grow rapidly.



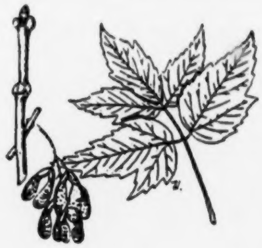
a. ____________________



b. ____________________

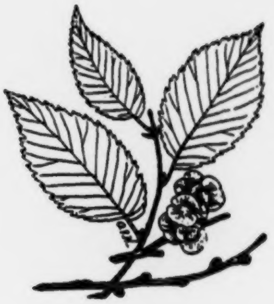


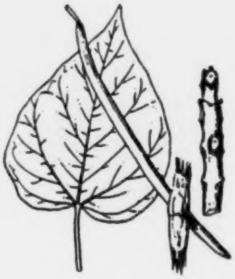
c. ____________________



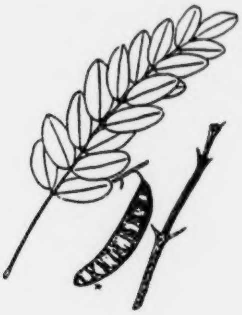
d. ____________________

TEST



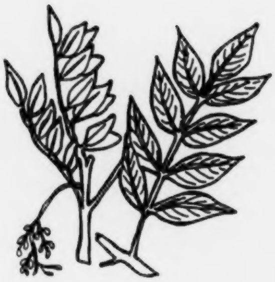


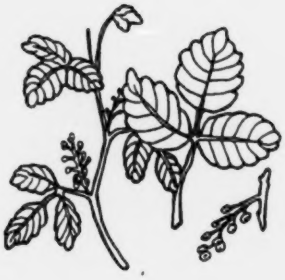
e. ______________________ f. ______________________

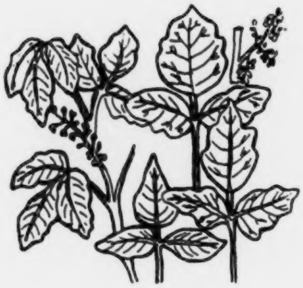


g. ______________________

12. Identify the following poisonous vegetation.







a. ______________ b. ______________ c. ______________

13. Evaluated on Assignment Sheet 1.

14. Evaluated on Assignment Sheet 2.

15. Evaluated on Assignment Sheet 3.

DISTRIBUTION TRANSFORMERS
UNIT 9

SUGGESTED ACTIVITIES

1. Suggested activities for instructor:

    - Provide student with objective sheet.
    - Provide student with information and assignment sheets.
    - Make transparencies.
    - Discuss unit and specific objectives.
    - Discuss information and assignment sheets.
    - Give test.

2. Unit references

    - Alerich, Walter N. and Keljik, Jeff. *Electricity 3, Motors and Generators, Controls, Transformers*. 5th ed. Albany, New York: Delmar Publishers Inc., 1991.
    - Kurtz, Edwin B., and Shoemaker, Thomas M. *The Lineman's and Cableman's Handbook*. 7th ed. New York: McGraw-Hill Book Co., 1986.
    - *OSHA Compliance Encyclopedia*. OSHA Regulations, April 1994. Business and Legal Reports, Inc. (ODA). "Electric Power Generations, Transmission and Distribution" 29 CFR Ch. XVII, Section 1910.269.
    - *Power Line Technician.* Stillwater, OK: Oklahoma Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.

DISTRIBUTION TRANSFORMERS
UNIT 9

ANSWERS TO TEST

1.
   a. 11
   b. 8
   c. 6
   d. 4
   e. 9
   f. 7
   g. 2
   h. 1
   i. 5
   j. 15
   k. 10
   l. 13
   m. 12
   n. 3
   o. 16
   p. 14
   q. 19
   r. 18
   s. 17

2.
   a. Transfers current from one circuit to another with no physical connection
   b. Transforms voltage from high voltage to low voltage
   c. Transforms voltage from low voltage to high voltage

3.
   a. High-voltage bushing
   b. Low-voltage bushings
   c. Low-voltage circuit breaker
   d. Low-voltage lead
   e. Transformer tank
   f. Transformer coils
   g. Tank grounding lug
   h. Internal high-voltage fuse
   i. Lightning arrester
   j. Low-voltage circuit breaker reset handle
   k. Transformer core

ANSWERS TO TEST

4. b

5. a. Oil-cooled

   b. Air-cooled

6. a. 3 d. 6

   b. 2 e. 4

   c. 1 f. 5

7. a. O d. A

   b. O e. A

   c. O f. O

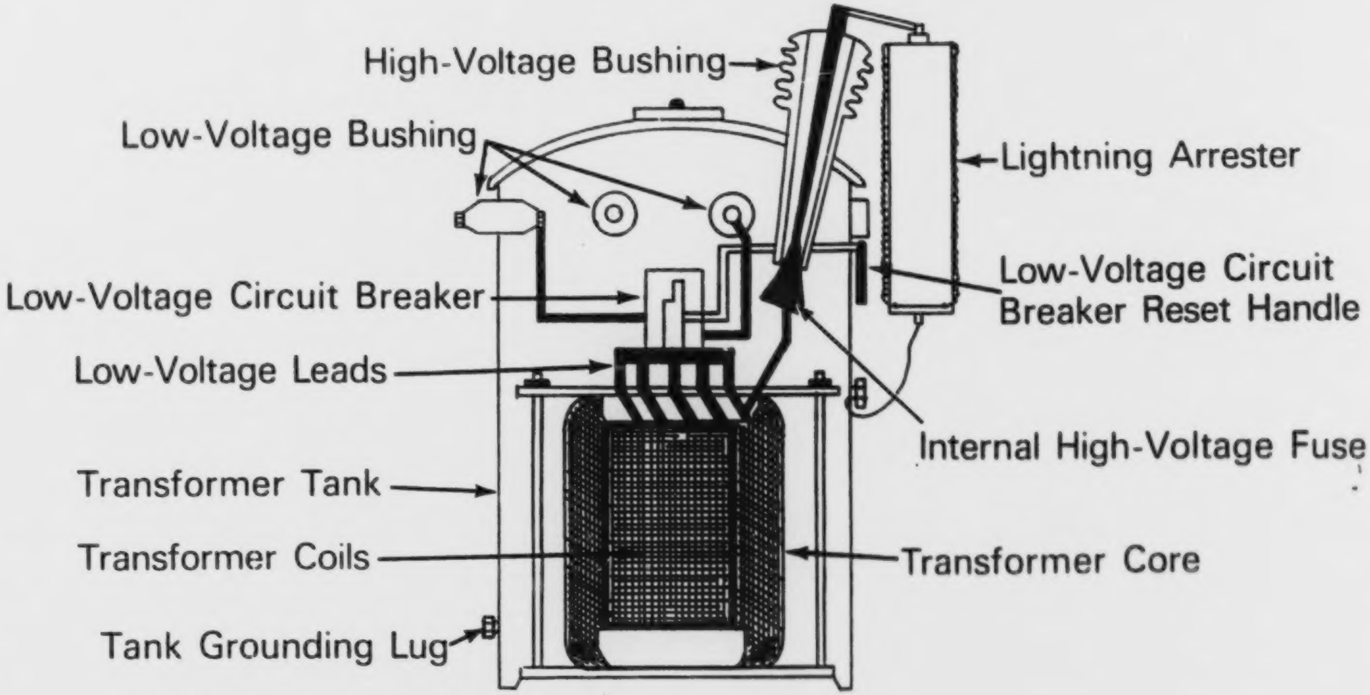
8. - Grounding and jumpering use
     1. Protection of people from electric shock
     2. Applicable to work at transmission voltages, overhead and underground distribution, in substations and with trucks
   - Methods of grounding and jumpering
     1. Temporary protective grounds
     2. Attach worksite safety jumper to the structure just below the worker's feet to provide a safe work zone
     3. Use system neutrals and static wires in parallel with driven grounds.
     4. Use protective mats
   - Step and touch potential
     1. Voltage-Gradient Distribution Curve
     2. Resistance

ANSWERS TO TEST

- Single point versus double point grounding
    1. Single point grounding places a safety jumper on the work tower only
    2. Double point grounding places jumpers on the tower on either side of the work tower
- Equipment requirements
    1. Clamps
    2. Cable
    3. Connections
        a. Ground rod
        b. Steel water main

9. Evaluated to instructor's satisfaction based on nameplate used.

Parts of a Completely Protected Transformer

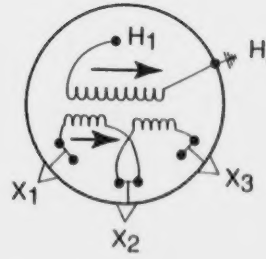

High-Voltage Bushing
Low-Voltage Bushing
Lightning Arrester
Low-Voltage Circuit Breaker
Low-Voltage Circuit Breaker Reset Handle
Low-Voltage Leads
Internal High-Voltage Fuse
Transformer Tank
Transformer Coils
Transformer Core
Tank Grounding Lug

May be photocopied for student use.

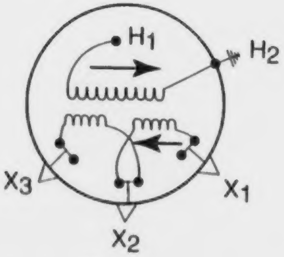
TM 1

PLT B - 9 - 7

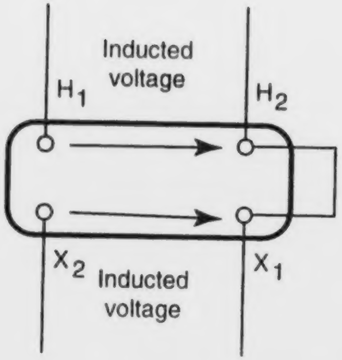
Additive And Subtractive Polarity

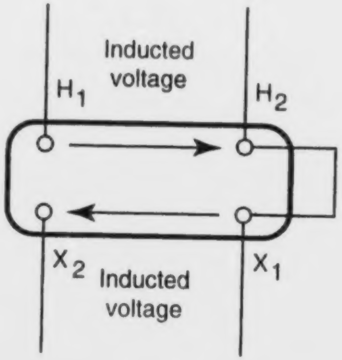

H1
H2
X1
X2
X3

Subtractive

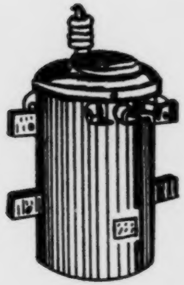

H1
H2
X3
X2
X1

Additive

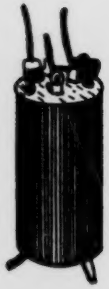

Inducted voltage
H1
H2
X2
X1
Inducted voltage


Inducted voltage
H1
H2
X2
X1
Inducted voltage

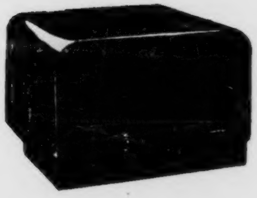
Oil-Cooled Transformers



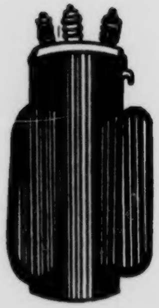
Pole Mount
(Completely Protected or
Conventional)



Submersible



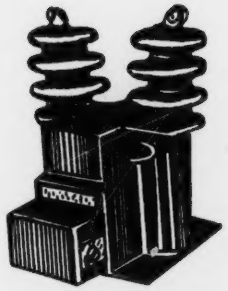
Pad Mount



Autotransformer

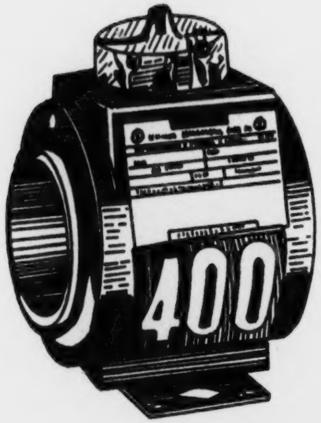
Air-Cooled Transformers

POTENTIAL

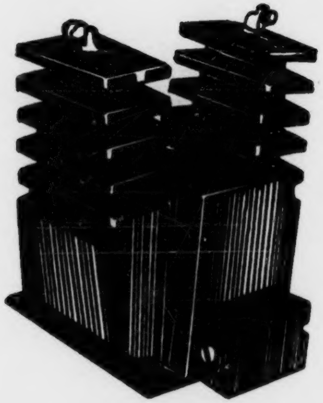


High Voltage

CURRENT

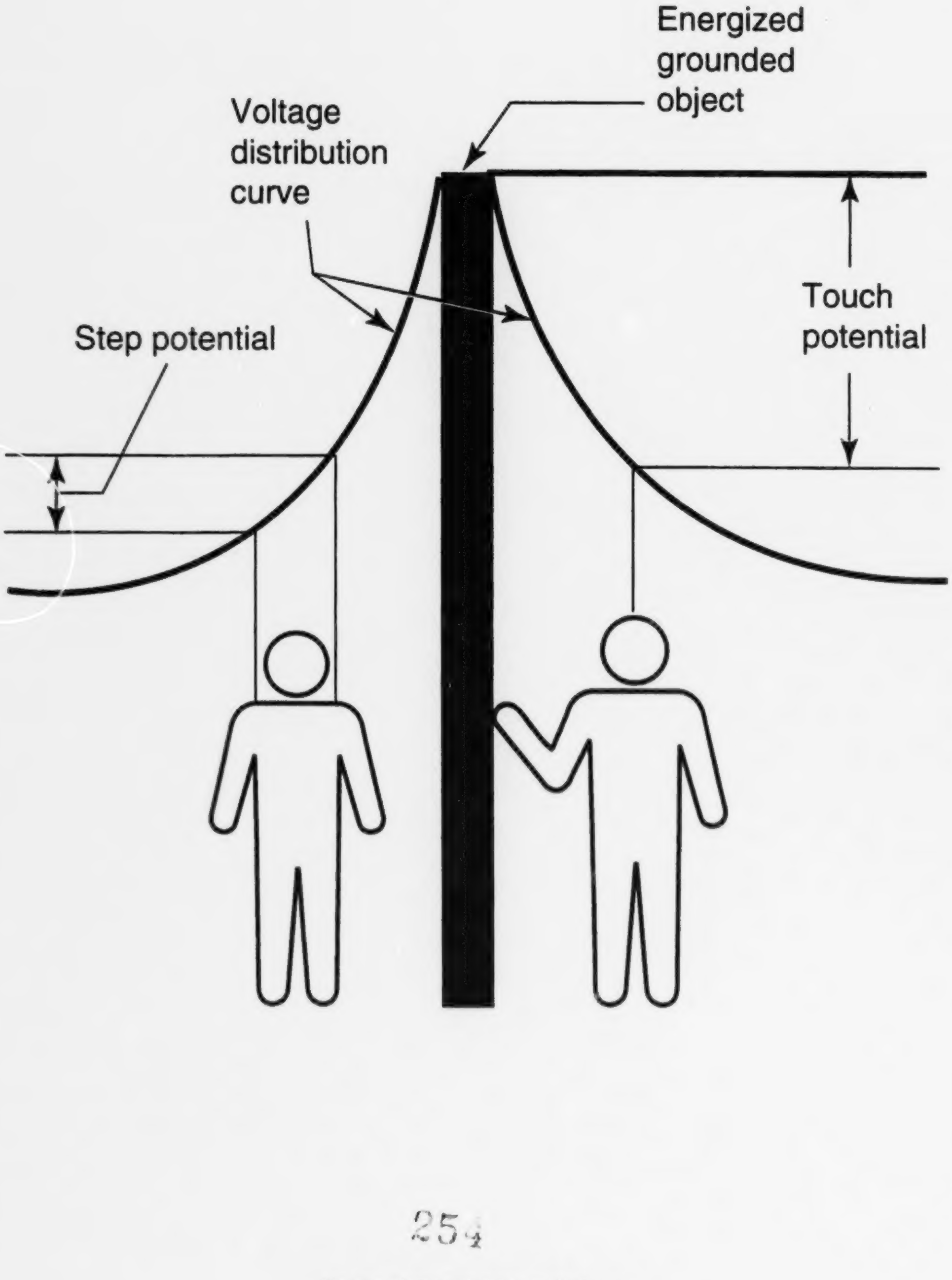


Low Voltage

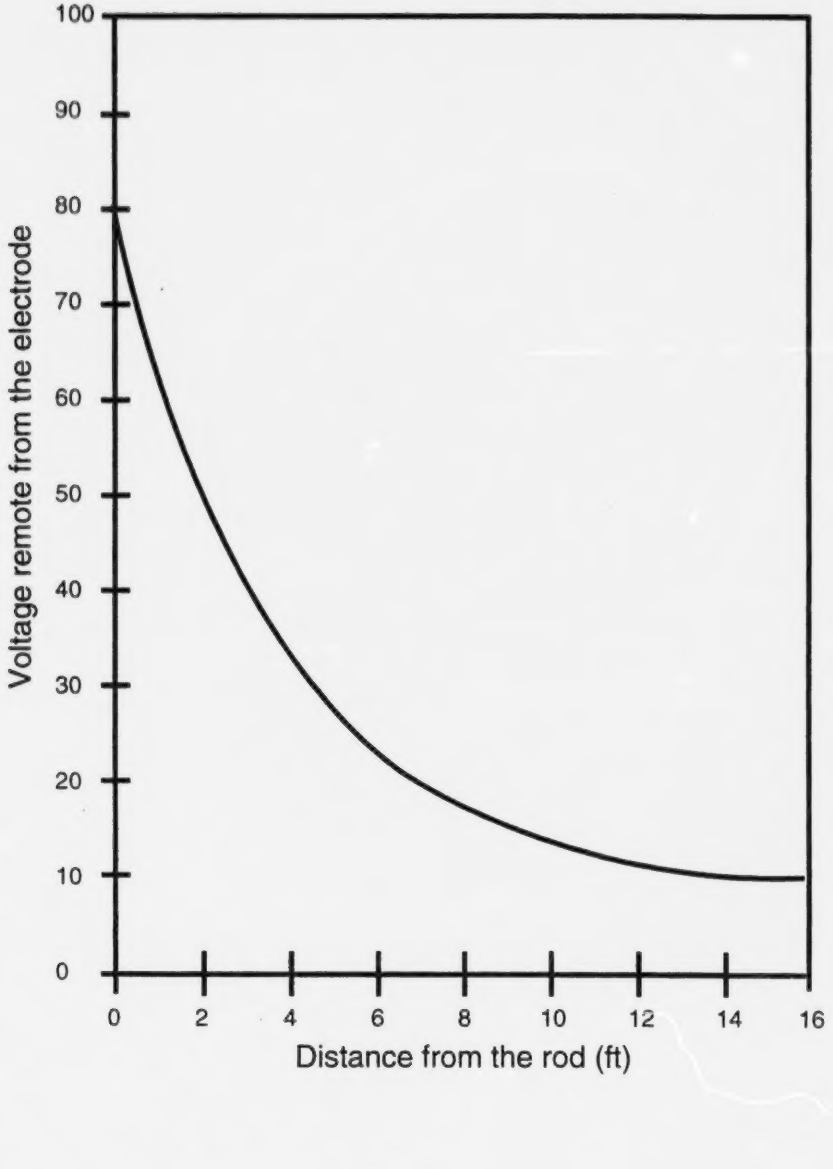


High Voltage

Step and Touch Potentials

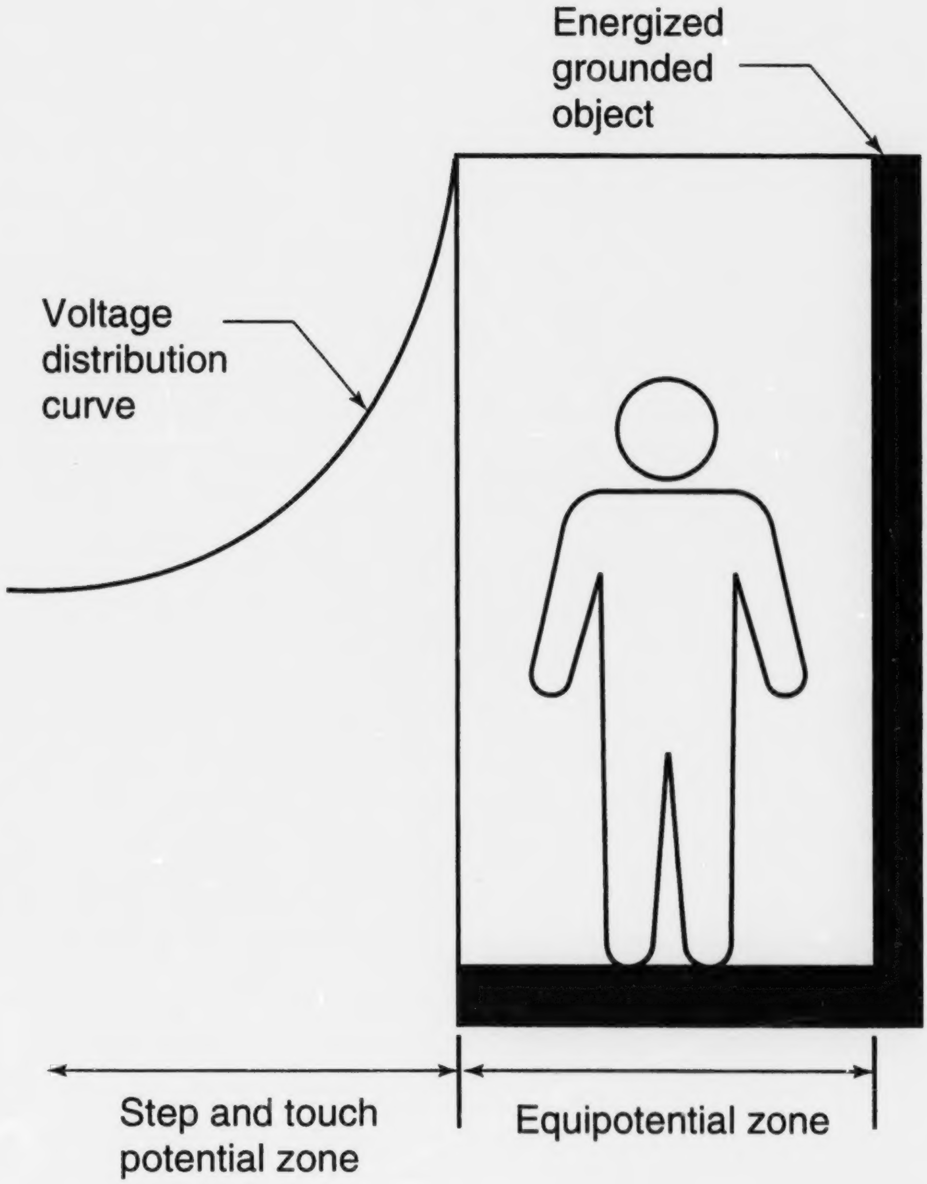

Energized
grounded
object
Voltage
distribution
curve
Step potential
Touch
potential

Typical Voltage-Gradient Distribution Curve



TM 6

Equipotential Zone


Energized
grounded
object
Voltage
distribution
curve
Step and touch
potential zone
Equipotential zone

TM 7

May be photocopied for student use.

DISTRIBUTION TRANSFORMERS
UNIT 9

TEST

NAME ______________________________ SCORE ____________

1. Match the terms on the right to the correct definitions.

_____a. Winding to which voltage is applied

_____b. Rating of a transformer

_____c. Transformer which has a high voltage lightning arrester, primary fuse, and a built-in low voltage circuit breaker

_____d. A conducting connection between an electric circuit or equipment and the earth, or to some conducting body that serves in place of the earth

_____e. Transformer installed with only an internal fuse for protection

_____f. Unit composed of primary and secondary windings on a laminated metal core

_____g. Bushing made of porcelain or other nonconductive material which insulates high voltage from the transformer tank

_____h. The voltage between the energized object and the feet of a person in contact with the object. It is equal to the difference in voltage between the object (which is at a distance of 0 feet) and a point some distance away.

_____i. Metal enclosure which houses the transformer core, coils, and cooling oil

_____j. Unit in some transformers which increases or decreases the number of turns on the primary winding

_____k. Opposition to current flow in an alternating current circuit

1. Touch potential
2. High-voltage bushing
3. Low-voltage bushing
4. Grounding
5. Transformer tank
6. Completely Protected (self-protected) transformer
7. Core and coil assembly
8. kVA (kilovolt-ampere)
9. Conventional transformer (type"S")
10. Impedance
11. Primary winding
12. Secondary winding
13. Step potential
14. Transformer record
15. Tap changer

TEST

_____l. The voltage between the feet of a person standing near an energized grounded object. It is equal to the difference in voltage, given by the voltage distribution curve, between two points at different distances from the "electrode".

_____n. Bushing made of nonconductive material which insulates the low voltage from the transformer tank

_____o. Turns on the primary winding related to turns on the secondary winding; the ratio between the primary and secondary voltage ratings

_____p. Printed form used to record information from a transformer

_____q. The use of low resistance conductors to bypass a work area

_____r. Indicates direction of current flow through the primary winding with respect to the direction of current flow through the secondary winding

_____s. Oil used in transformer tank to insulate and cool core and coil assembly

16. Transformer-turns ratio
17. Transformer oil
18. Polarity
19. Jumpering

2. State three functions of a transformer.

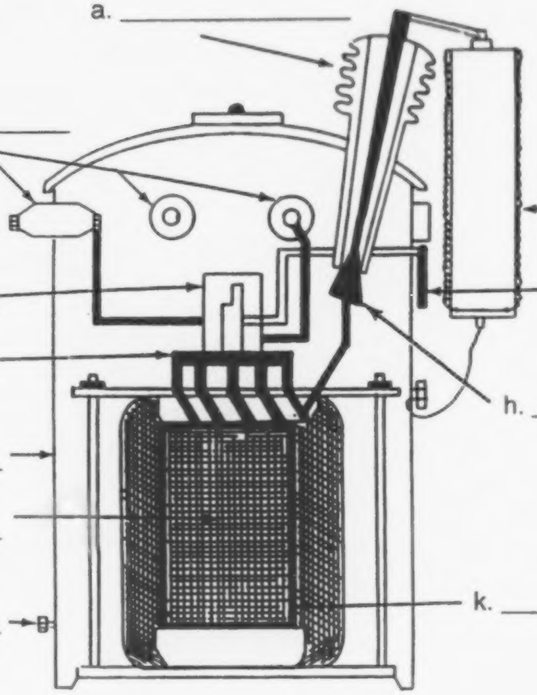
a. ____

b. ____

c. ____

TEST

3. Identify the parts of the completely protected transformer in the diagram below.



a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

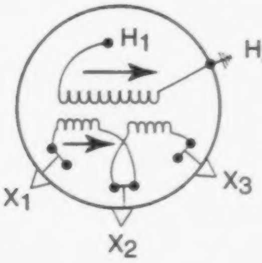
i. ____________________

j. ____________________

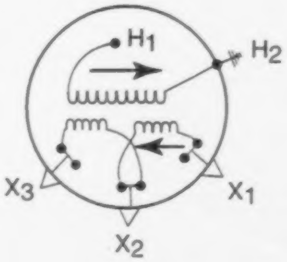
k. ____________________

TEST

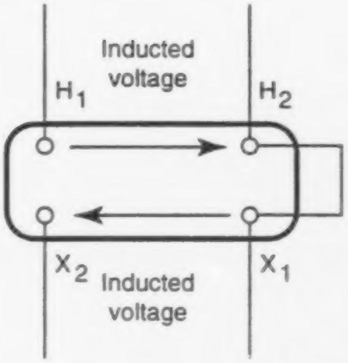
4. Distinguish between additive and subtractive polarity as they relate to transformers by placing an "X" under the illustration of additive polarity.

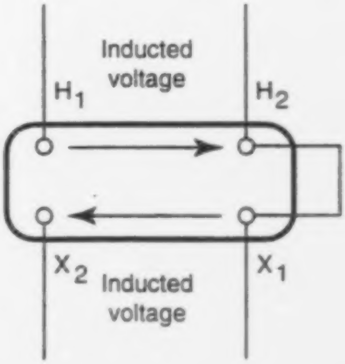

H1
H2
X1
X3
X2

Subtractive


H1
H2
X3
X1
X2

Additive


Inducted voltage
H1
H2
X2
X1
Inducted voltage


Inducted voltage
H1
H2
X2
X1
Inducted voltage

a. ______________________ b. ______________________

TEST

5. List two kinds of transformers.

   a. ____________________

   b. ____________________

6. Match the types of transformers on the right to the correct descriptions.

   _____a. Oil-cooled transformer with side-mounted hangers installed on a pole

   _____b. Oil-cooled transformer installed on a plastic or concrete pad in commercial or residential underground distribution system

   _____c. Oil-cooled transformer installed in a concrete or fiber vault for residential distribution

   _____d. Air-cooled transformer used to reduce voltage for testing or metering purposes

   _____e. Oil-cooled transformer in which the primary and secondary have a common winding

   _____f. Air-cooled transformer used with metering equipment

   1. Submersible
   2. Pad mount
   3. Pole mount
   4. Autotransformer
   5. Current transformer
   6. Potential transformer

7. Classify the following types of transformers by placing an "O" in the blanks for oil-cooled and an "A" for air-cooled.

   _____a. Pole mount

   _____b. Pad mount

   _____c. Submersible

   _____d. Potential

   _____e. Current

   _____f. Autotransformer

TEST

8. Discuss the technical considerations in protective grounding and jumpering. Explain why each area is important.

   a. Use — ______________________________

   b. Methods — ______________________________

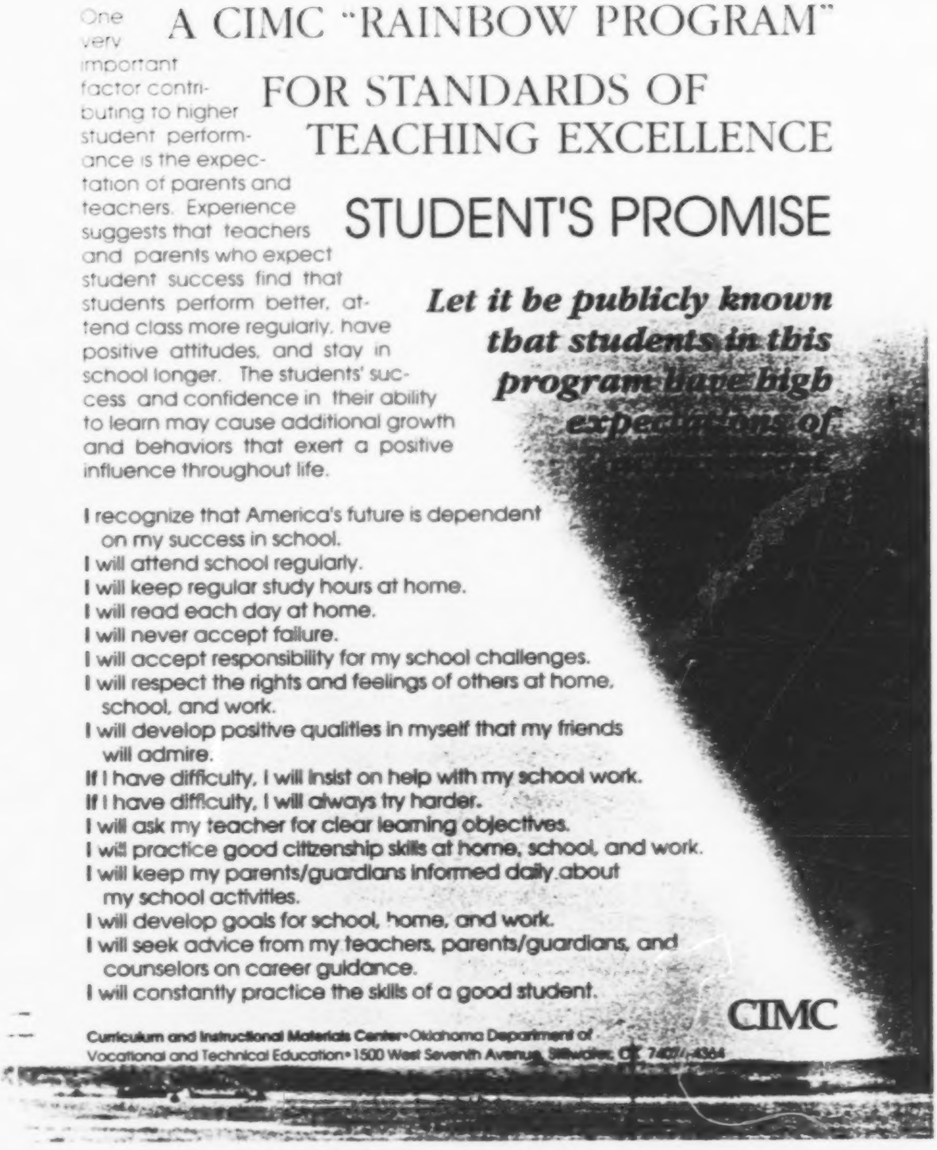
   c. Step and touch potential — ______________________________

   d. Single point versus double point grounding — ______________________________

   e. Equipment requirements — ______________________________

TEST

9. List information found on a transformer nameplate.



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STUDENT'S PROMISE

One very important factor contributing to higher student performance is the expectation of parents and teachers. Experience suggests that teachers and parents who expect student success find that students perform better, attend class more regularly, have positive attitudes, and stay in school longer. The students' success and confidence in their ability to learn may cause additional growth and behaviors that exert a positive influence throughout life.

Let it be publicly known that students in this program have high expectations of [illegible]

I recognize that America's future is dependent on my success in school.
I will attend school regularly.
I will keep regular study hours at home.
I will read each day at home.
I will never accept failure.
I will accept responsibility for my school challenges.
I will respect the rights and feelings of others at home, school, and work.
I will develop positive qualities in myself that my friends will admire.
If I have difficulty, I will insist on help with my school work.
If I have difficulty, I will always try harder.
I will ask my teacher for clear learning objectives.
I will practice good citizenship skills at home, school, and work.
I will keep my parents/guardians informed daily about my school activities.
I will develop goals for school, home, and work.
I will seek advice from my teachers, parents/guardians, and counselors on career guidance.
I will constantly practice the skills of a good student.

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Power Line Technician

Second Edition

Module B

- Personal and Job Safety
- Communications
- Basic Electrical Theory
- Rope and Rigging
- Overhead Construction
- Underground Distribution Construction
- Personal Climbing Tools and Equipment
- Right-of-Way
- Distribution Transformers

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Power Line Technician: Module B

Student Workbook

Developed by the
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97-012265

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3. Job Advancement
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MODULE B

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2. Communications
3. Basic Electrical Theory
4. Rope and Rigging
5. Overhead Construction
6. Underground Distribution Construction
7. Personal Climbing Tools and Equipment
8. Right-of-Way
9. Distribution Transformers

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PERSONAL AND JOB SAFETY
UNIT 1

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe the procedures for various types of rescue situations, select the proper fire extinguisher to control a fire, and drive safely. The student should be able to inspect and maintain mechanical equipment and work safely. This knowledge will be evidenced by scoring 100 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with personal and job safety to the correct definitions.
2. Describe the procedures to follow for various types of rescue situations.
3. List components necessary for fire.
4. Match classes of fires to the correct description of each.
5. Match types of fire extinguisher to the class or classes of fire each is best suited to extinguish.
6. List general safety precautions to observe during rescue.
7. Discuss in a short paragraph driving skills needed by a line technician.
8. List some poor attitudes that may cause accidents.
9. Select from a list requirements of a skilled driver.
10. List steps of defensive driving.
11. Identify shapes of traffic signs.
12. Select from a list some general safety precautions to observe when operating equipment.
13. State OSHA/DOT regulations for inspection of equipment.
14. Select from a list the items which should be inspected daily on mechanical equipment.
15. List methods for maintaining a clean and orderly work area.

OBJECTIVE SHEET

16. Explain how to lift heavy objects.

17. Describe in a short paragraph the importance of safety communications.

18. Select from a list those items of importance that should be reported to the supervisor.

19. Select from a list items related to safety that a line technician should know concerning location and voltage.

20. State factors which determine the maximum weight which can be lifted by equipment.

21. Determine maximum weight that can be lifted by equipment at various angles. (Assignment Sheet 1)

22. Complete a safety pledge form. (Assignment Sheet 2)

PERSONAL AND JOB SAFETY
UNIT 1

INFORMATION SHEET

1 Match terms associated with personal and safety to the correct definitions.

- Accident -- Unplanned or unscheduled event which may or may not cause personal injury or property damage
- First aid — Immediate and temporary care of an accident or sudden illness victim until the service of a physician is obtained
- Basic life support — Manual method of sustaining life until advanced life support system is available

  Example: Cardiopulmonary resuscitation (CPR)
- Personal protective equipment — Equipment worn on or about the body to help prevent bodily injury
- Procedure — Series of steps followed in a definite order
- precaution — Measure taken beforehand to prevent harm or damage
- Attitude — Mental position regarding an act or state
- Rescue — Procedure of freeing from imminent danger by prompt action
- Inspection — Act of viewing closely in critical appraisal
- OSHA (Occupational Safety and Health Act) — Federal legislation designed to insure safe and sanitary working conditions for employees
- Equipment safety — Proper use, care, and inspection of equipment
- Job safety — Following procedures, codes, and methods prescribed in safety standards
- Personal safety — Consistent use and care of items intended for use as safeguards
- Safety — State or condition of being safe; freedom from danger, risk, or injury

INFORMATION SHEET

2. Describe the procedures to follow for various types of rescue situations.

   (NOTE: Secure the area, and use all personal protective equipment provided, in all situations.)

   - Pole top

     1. Remove electrical source from victim
     2. Restore breathing
     3. Lower victim to ground (Transparency 1)

     (NOTE: If the victim is not breathing and does not have a pulse, lower victim to ground immediately and start CPR.)

   - Energized vehicle

     1. Disconnect or remove source of electricity
     2. Have fire extinguisher ready for use
     3. Clear all lines from vehicle

     (NOTE: Keep all persons clear of energized vehicle to prevent contact with it. If the person or persons in the energized vehicle are not injure, they may jump clear, making sure that contact is not made between the vehicle and the ground.)

   - Electric shock

     1. Remove source of electricity
     2. Check pulse and respiration
     3. Begin CPR if needed

   - Aerial device

     1. Be sure vehicle is not energized
     2. Lower platform or basket with override controls
     3. Remove victim from platform or basket
     4. Check victim for injuries, pulse, and respiration and being CPR if needed

   - Fire

     1. Place thick wet cloth over mouth and nose
     2. Check doors for extreme heat before opening
     3. Crouch low and stay behind door when opening

INFORMATION SHEET

3. List components necessary for fire. (Transparency 2)

   - Fuel
   - Heat
   - Oxygen

   (NOTE: The removal of any one of the necessary components will prevent or extinguish a fire.)

4. Match classes of fires to the correct description of each.

   - Class A — Fires that occur in ordinary combustible material such as wood, rags, and rubbish
   - Class B — Fires that occur with flammable liquids such as gasoline, oil, grease, paint, and thinners
   - Class C — Fires that occur in or near electrical equipment such as motors, transformers, switchboards, and electrical wiring
   - Class D — Fires that occur with combustible metals such as iron and magnesium

5. Match types of fire extinguisher to the class or classes of fire each is best suited to extinguish.

   - pressurized water — Used on Class A fires
   - Carbon dioxide (CO_2) — Used on Class B and C fires
   - Dry chemical — Used on Class B, C, and D fires

     (NOTE: Dry chemical extinguisher should be shaken before use to loosen packed chemicals.)

   - Foam — Used on Class A and B fires

     (CAUTION: Do not use water on burning liquids because the fire will spread. Hot oil may explode if water comes in contact with it. Do not use water on electrical fires.)

6. List general safety precautions to observe during rescue.

   - Do not endanger yourself just to be a hero

     (NOTE: A rescue cannot be accomplished if the rescuer becomes another victim.)

INFORMATION SHEET

- Acquire the tools or equipment needed to carry out a rescue
- Follow safety procedures
- Notify proper authority

  Examples: Supervisor, police, ambulance
- Request assistance if needed

7. Discuss in a short paragraph driving skills needed by a line technician.

- Obey all traffic laws
- Respect the rights of others
- Drive defensively
- Use seat belts
- Practice good housekeeping

  (NOTE: Items hanging from sun visors or laying on the dashboard restrict vision and should be properly stored.)
- Be aware of vehicle limitations

  Examples: Stopping distance, weight
- Drive only in areas where vehicle damage will not occur

8. List some poor atttudes that may cause accidents.

- Accidents happen to the other guy
- Shortcuts save time
- Safety rules are for other people
- Breaking safety rules is alright if you don't get caught
- I have done this before and didn't get hurt
- Speeding is alright if you are a good driver

9. Select from a list requirements of a skilled driver.

- Obeys all state and local traffic laws

INFORMATION SHEET

- Maintains current and proper class commercial driver's license (CDL)

  (NOTE: Class A: Any combination of vehicles with a gross combination weight rating of 26,001 pounds or more, provided the gross vehicle weight rating of the vehicle or vehicles towed exceeds 10,000 pounds.

  Class B: Any single vehicle with a gross vehicle weight rating of 26,001 pounds or more and any one of those vehicles towing another vehicle with a gross vehicle weight rating that does not exceed 10,000 pounds.

  Class C: Any single vehicle with a gross vehicle weight rating of less than 26,001 pounds and any one of those vehicles towing another vehicle with a gross vehicle weight rating that does not exceed 10,000 pounds if either vehicle is: 1) designed to transport 16 or more passengers including the driver; or 2) used in the transportation of hazardous materials that require the vehicle be placarded under 40 CFR, Part 172, Subpart F.)

- Allows no one to ride outside of vehicle
- Allows no one to mount or dismount while vehicle is in motion
- Passes other vehicles only when there is sufficient distance to do so safely
- Signals intent when turning, changing lanes, or stopping
- Yields to void an accident even if he/she has the right-of-way
- Follows other vehicles at a safe distance
- Keeps transmission engaged when descending grades
- Checks to the rear before backing
- Maintains good visibility
- Sets parking brake, places transmission in gear, and chocks wheels when parking on a grade
- Attaches red flag to load if extended four feet or more beyond truck body
- Places flares or reflectors if vehicle is stalled

10. List steps of defensive driving.

- Aim high in steering

  (NOTE: Seeing ahead of the car in front of you is the minimum distance that should be constantly observed.)

INFORMATION SHEET

- Get the big picture

  (NOTE: Use your full vision capabilities in front, to the rear, and to each side.)

- Keep eyes moving

  (NOTE: Never let an object hold your attention. At highway speeds a lot can happen in two seconds.)

- Leave yourself an out

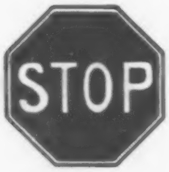
  (NOTE: Adjust your speed to the conditions and be ready to brake or veer if the situation requires it.)

- Make sure other drivers see you

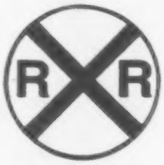
  (NOTE: Traffic laws will not protect you if your presence is not known to approaching drivers.)

11. Identify shapes of traffic signs. (Transparency 3)

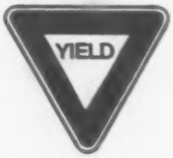
- Stop



- Railroad crossing

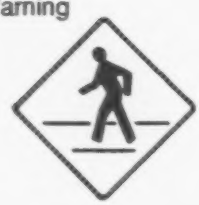


- Yield right-of-way



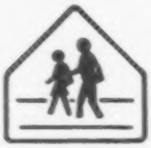
INFORMATION SHEET

- Warning

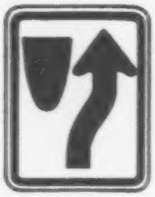


(NOTE: The diamond-shaped traffic sign indicates danger ahead, such as a sharp curve, narrow bridge, or stop sign.)

- School area



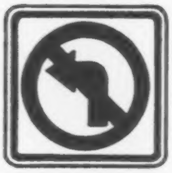
- Service and guide

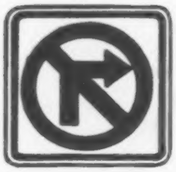


(NOTE: Service and guide signs inform of bike routes, hospitals, telephones, camping areas, and hiking trails.)

INFORMATION SHEET

- Regulatory





(NOTE: Regulatory signs indicate that certain things or actions are prohibited. These things or actions include no bicycles, no U-turns, or no trucks allowed, or no right or left turn.)

12. Select from a list some general safety precautions to observe when operating equipment.

    - Do not overload equipment
    - Do not let anyone stand under load or boom
    - Do not put side strain on rotating boom
    - Do not wear jewelry
    - Tie back long hair
    - Ground equipment when working near energized line
    - Make sure everyone is clear before extending outriggers or stabilizers
    - Be sure outriggers or stabilizers are on solid footing
    - Operate only the equipment you are trained and authorized to use

13. State OSHA/DOT regulations for inspection of equipment.

    - Inspection prior to each use by competent person designated by employer
    - Annual inspection by competent person, government agency, or private agency recognized by the Department of Labor

    (NOTE: Inspection and testing of insulating equipment is done by an approved agency annually. See current OSHA/ANSI/ASTM standards.)

INFORMATION SHEET

14. Select from a list the items which should be inspected daily on mechanical equipment.

- Daily inspection of vehicles

  (NOTE: Use "Drivers Daily Vehicle Inspection Report" that is in the Drivers Daily Log Book for check off list.)

  1. Service brake including trailer brake connections
  2. Parking (hand) brake
  3. Steering mechanism
  4. Lighting devices and reflectors
  5. Tires
  6. Horn
  7. Windshield wipers
  8. Rear vision mirrors
  9. Coupling devices
  10. Wheels and Rims
  11. Fire extinguisher

      (NOTE: Must be securely mounted on vehicle, properly filled and located so that it is readily accessible for use. Check with insurance carrier for size and type. For example, two 10 pound dry chemical.)

  12. First aid kit
  13. Personal protective equipment

      (NOTE: Specialized clothing or equipment worn by an employee for protection against a hazard, such as bloodborne pathogens. General work clothes not intended to function as protection against a hazard are not considered to be personal protective equipment.)

INFORMATION SHEET

14. Emergency equipment

    (NOTE: Emergency equipment may include, but is not limited to fire extinguisher(s), spare electrical fuses, and warning devices for parked vehicles. Warning devices may be liquid burning flares and two red flags, or three electric emergency lanterns, or three red emergency reflectors, or three red emergency reflective triangles.)

- Daily inspection of rotating-lifting equipment

  1. Hydraulic system filters
  2. Hydraulic hoses
  3. Hydraulic cylinders
  4. Cylinder attachment points
  5. Boom

  (NOTE: A filter check will indicate excessive collection of contaminants if hydraulic cylinder seals or packing is damaged. A close check of hoses, cylinders, cylinder attachment points, and boom will reveal any broken welds or cracks.)

  6. Proper marking of controls and decals
  7. Dielectric oil
  8. Capacity chart for boom
  9. Hydraulic/Pneumatic tools

     (NOTE: Check hose, hose fittings, on all tools such as tamp, polejack, saw, trimmers, compression tools, etc.)

15. List methods for maintaining a clean and orderly work area.

- Store equipment that is not in use
- Stack packing materials and boxes and dispose of properly
- Place materials in proper storage area after removing from job
- Keep scrap and excess wire picked up and stored in proper place
- Pick up all litter
- Place all combustible or hazardous materials in proper containers

INFORMATION SHEET

- Place covers, guards, shields provided on all sharp, pointed or cutting edges

16. Explain how to lift heavy objects. (Transparency 4)

    - Lift with legs, not with back
    - Keep back straight
    - Do not lift heavy objects without help

17. Describe in a short paragraph the importance of safety communications.

    (NOTE: It is extremely important that other crews which might be working in the same area be aware of your location and job plans. An accident can easily happen if a line is energized by a crew that is unaware of your presence. If the person you are working with is working close to an energized conductor, remind him/her of the situation. He/she may not know how close the conductor is. This type of communication is essential for all members of a crew whether they are working on a structure or on the ground.)

18. Select from a list those items of importance that should be reported to the supervisor.

    - Unsafe conditions
    - Unsafe tools
    - Unsafe equipment
    - Unsafe acts
    - Job location
    - Change of location
    - Change of job plans
    - All accidents

19. Select from a list items related to safety that a line technician should know concerning location and voltage.

    - Location
        1. Circuit breakers
        2. Regulators
        3. Capacitor stations

INFORMATION SHEET

4. Multi-feed transformer banks
5. Private generators
6. Phase transpositions
7. Underground feeders
8. Transformer banks
9. Other suppliers' lines
10. Lines paralleled with other suppliers' lines
11. Substations
12. Loop feeds
13. Identify, mark, or label all the above

- Voltage

  1. Transformers (primary and secondary)
  2. Distribution lines
  3. Transmission lines
  4. Metering equipment
  5. Secondary lines
  6. Service lines

  (NOTE: Many systems use more than one distribution line voltage. This can be hazardous if the voltage rating of equipment to be installed is not the same as the line voltage to which the equipment is to be connected. Therefore, the line technician should be familiar with equipment locations and the line voltages.)

20. State factors which determine the maximum weight which can be lifted by equipment.

- Design

  (NOTE: Equipment constructed without stabilizers or outriggers will not have lifting capacities as great as equipment with them.)

INFORMATION SHEET

- Degree of elevation of lifting boom (Assignment Sheet 1)

  (NOTE: The maximum lifting capacity of any boom type equipment is determined by the degree of elevation of the boom. The closer the boom is to 90° elevation, the greater the lifting capacity will be.)

- Size and condition of cable

  (NOTE: Most equipment that is equipped with a winch has the capability of breaking a cable. The cable used should be of the proper size and type for the equipment and should be treated with care to avoid weakening its strength.)

- Rating (Transparency 5)

  (NOTE: Each piece of equipment that is designed to lift material will have a specification plate which designates the maximum weight that can be lifted and the degree of elevation the boom must be to lift it. The lower the degree of elevation is, the lower the lifting capacity will be.)

- Terrain

  (NOTE: An unlevel terrain adds to the problem of equipment placement. Care should be taken to not lift poles or equipment from the downhill side of lifting equipment.)

PERSONAL AND JOB SAFETY
UNIT 1

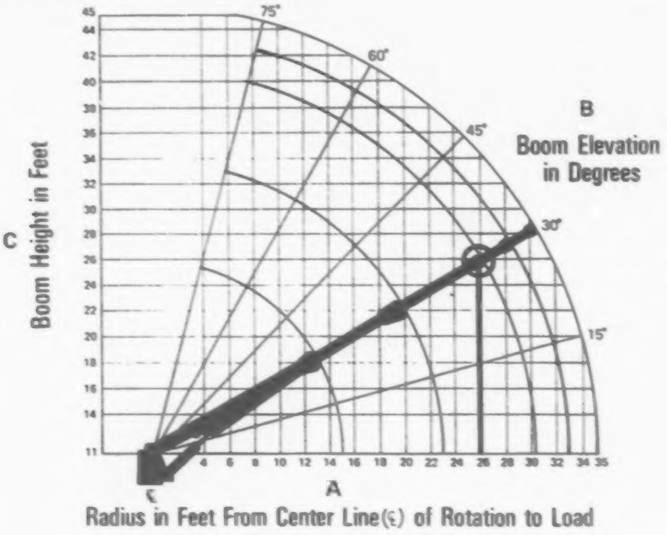
ASSIGNMENT SHEET 1

OBJECTIVE 21 — DETERMINE MAXIMUM WEIGHT THAT CAN BE LIFTED BY EQUIPMENT AT VARIOUS ANGLES.

The chart below indicates the maximum permissible load at various distances to load from center line (Line "A") and at various degrees of elevation (Line "B"). The numbers on the left side of the chart (Line "C") indicate the height in feet of the uppermost part of the boom at various feet of extension and at various degrees of elevation.

(NOTE: The degree of elevation is shown by a degree indicator attached to the side of the boom.)

Example: Radius to load is 26 feet (Line "A") and is elevated to 30 degrees (Line "B"). Maximum load is found in Line "F" under 26. Maximum load = 2200 lbs.



D

BOOM RETRACTED	LOAD RADIUS	4	5	6	8	10	12	15
	LOAD	11000	10000	8800	7400	6400	5600	4300

Deduct approx. 1000 pounds when equipped with digger.

E

BOOM EXTENDED	LOAD RADIUS	8	10	12	14	16	18	20	23
	LOAD	6200	5300	4800	4200	3800	3500	3200	2800

Deduct approx. 900 pounds when equipped with digger.

F

INSULATED BOOM EXTENSION	LOAD RADIUS	10	14	18	22	26	28	30	33	35
	LOAD	4500	3400	2900	2400	2200	2000	1800	1500	1200

Deduct approx. 900 pounds when equipped with digger.

DEDUCT 200 POUNDS FROM ALL CHARTS WHEN EQUIPPED WITH POLE CLAW.

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ASSIGNMENT SHEET 1

1. Determine height of boom at 16 feet from center line to load and 15 degrees elevation.

2. Determine maximum weight that can be lifted with load at 16 feet from center line and boom elevated to 15 degrees when equipped with digger.

3. Determine maximum weight that can be lifted with load at 4 feet from center line and 75 degrees elevation when equipped with pole claw and boom retracted.

   (NOTE: In order for load to be 4 feet from center line, boom must be completely retracted.)

4. Determine maximum weight that can be lifted with load at 35 feet from center line and 0 degrees elevation when equipped with digger and pole claw.

PERSONAL AND JOB SAFETY
UNIT 1

ASSIGNMENT SHEET 2

OBJECTIVE 22 — COMPLETE SAFETY PLEDGE FORM.

_______________________________________, who is enrolled in the power line technician's training course, will as part of her/his experience, operate equipment, providing that the parent or guardian gives written permission.

It is understood that each student will be given proper instruction in the use of equipment and the safety procedures concerning it before being allowed to operate it. The student must assume the responsibility for following safe practices and we therefore ask that the student subscribe to the following safety pledge.

1. I PROMISE TO FOLLOW ALL SAFETY RULES AND PRACTICES.
2. I PROMISE NEVER TO USE A PIECE OF EQUIPMENT WITHOUT FIRST HAVING PERMISSION FROM THE SUPERVISOR.
3. I WILL NOT ASK TO USE A PIECE OF EQUIPMENT UNLESS I HAVE BEEN INSTRUCTED IN ITS USE.
4. I WILL REPORT ANY ACCIDENT OR INJURY TO THE SUPERVISOR IMMEDIATELY.

DATE __________ STUDENT'S SIGNATURE ________________________

I hereby give my consent to allow my son or daughter to operate all equipment necessary in carrying out the requirements of the course in which he/she is enrolled.

DATE __________ PARENT'S SIGNATURE ________________________

(NOTE: Parental permission is necessary only if the student is a minor.)

COMMUNICATIONS
UNIT 2

UNIT OBJECTIVE

After completion of this unit, the student should be able to communicate correctly with others by radio and by using hand signals. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. List types of communications necessary for an REC employee.
2. Select from a list those items of communication that are important between fellow workers.
3. List items of communication that are important between the worker and the supervisor.
4. Select from a list those items of communication that are important between the worker and the general public.
5. Identify hoist signals.
6. Identify winch line signals.
7. Identify hand signals used in boom operations.
8. Identify hand signals used when maneuvering vehicles.
9. Identify line work signals.
10. Select from a list the proper radio procedures.
11. State emergency radio procedure.
12. Select from a list the prohibited uses of the radio.
13. Match radio code signal numbers to the correct meanings.
14. List factors that are important when using cellular mobile telephones.

COMMUNICATIONS
UNIT 2

INFORMATION SHEET

1. List types of communications necessary for an REC employee.

   - Verbal

     (NOTE: Communications with the supervisor, crew members, and general public are among the most important communications.)

   - Hand Signals

     (NOTE: When working with equipment, noise levels make it difficult to communicate verbally. The knowledge and use of hand signals is an important part of communication under these conditions.)

   - Radio

     (NOTE: Communicating by radio is the most efficient means of contacting crews in the field or obtaining information from the base station. Knowledge of the use and procedure of radio operation is an essential part of communications. If an emergency situation exists, radio use should be held to a minimum in order to let those involved transmit their messages.)

   - Cellular mobile telephones

     (NOTE: Knowing how to use a cellular mobile telephone is a vital component of communications. Cellular mobile telephones are an effective medium for communicating with the office, customers or emergency personnel.)

   - Written

     (NOTE: Any information needed for records or referral should be in written form.)

2. Select from a list those items of communication that are important between fellow workers.

   - Pole buddy or other crew members

     1. What you are doing

     2. What your buddy's position is in relation to energized conductors or other unsafe conditions

INFORMATION SHEET

- Other crews
    1. Where you are
    2. What you are doing
- Radio dispatcher
    1. When you arrive at a job site
    2. When you leave a job site
    3. When you are going to be away from your radio

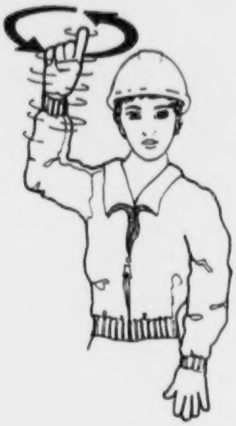
    (NOTE: All activities should be coordinated through the dispatcher.)

3. List items of communication that are important between the worker and the supervisor.
    - Worker's responsibility
    - Supervisor's responsibility
    - Worker's authority
    - Supervisor's authority
    - Unsafe conditions of tools and equipment
    - Unsafe acts
    - All accidents
4. Select from a list those items of communication that are important between the worker and the general public.
    - Programs of your organization
    - Purpose of your organization
    - Hazards to the public at job site

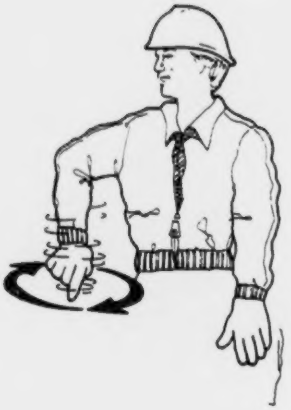
    (NOTE: Warning signs or barricades should be placed to protect the public.)
5. Identify hoist signals. (Transparency 1)

INFORMATION SHEET

- Raise the load

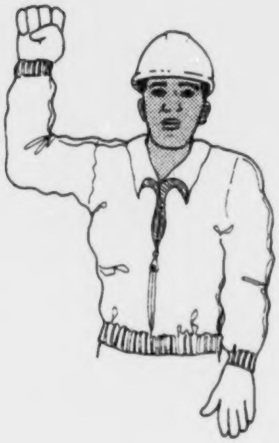


- Lower the load

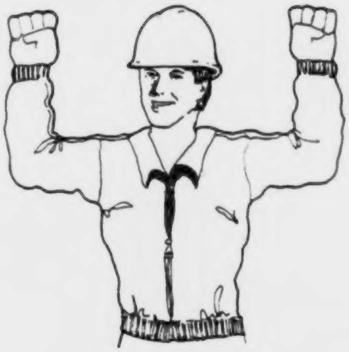


INFORMATION SHEET

- Stop



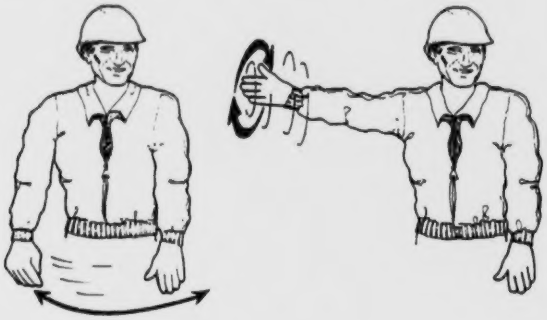
- Emergency stop



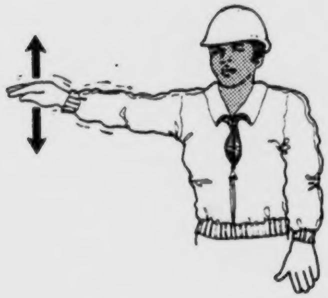
INFORMATION SHEET

6. Identify winch line signals. (Transparency 2)

- Pull

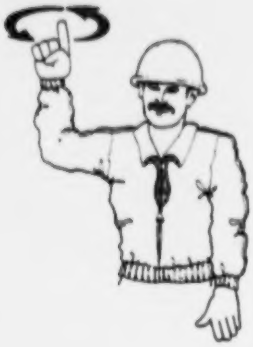


- Lower

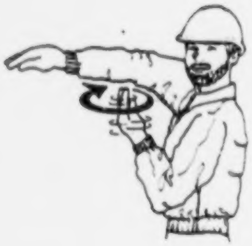


INFORMATION SHEET

- Hoist

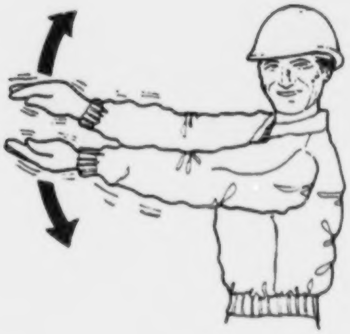


- Take up slow or raise a little



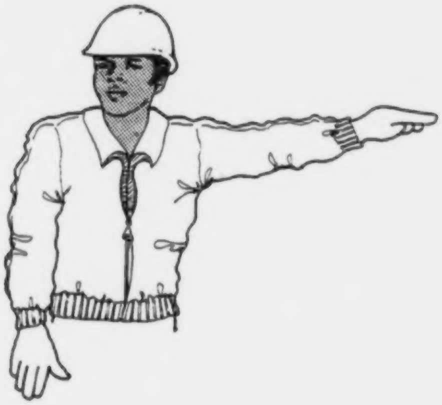
INFORMATION SHEET

- Slack off slow or lower a little



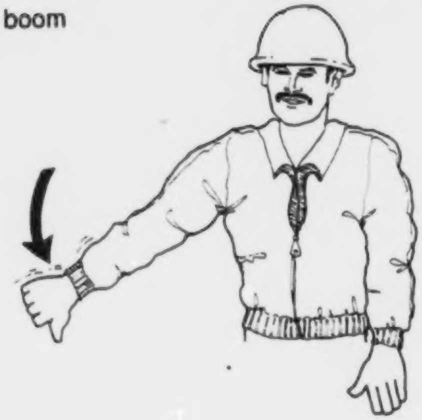
7. Identify hand signals used in boom operations. (Transparency 3)

- Swing in direction finger points

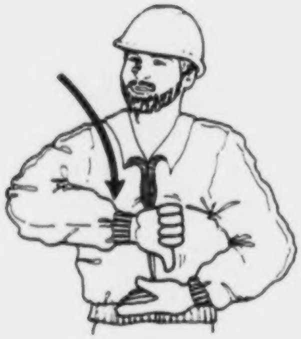


INFORMATION SHEET

- Lower the boom

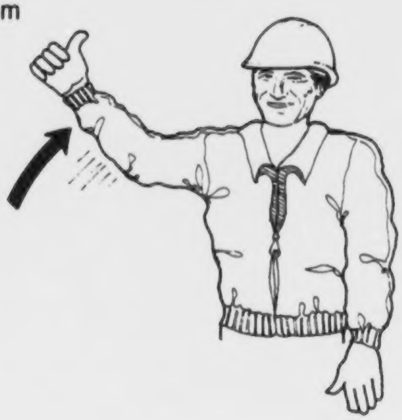


- Lower the boom slowly

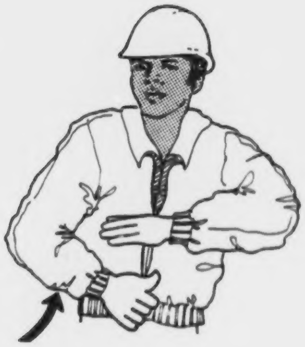


INFORMATION SHEET

- Raise the boom

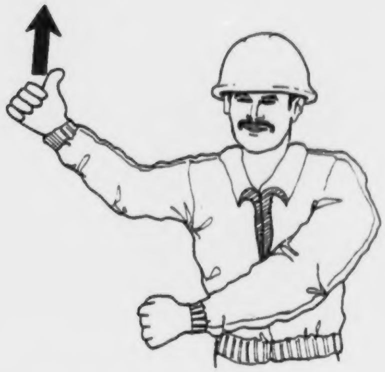


- Raise the boom slowly

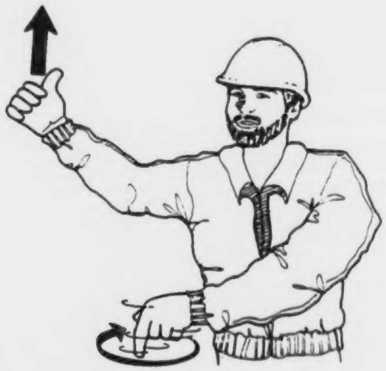


INFORMATION SHEET

- Raise the boom and hold the load

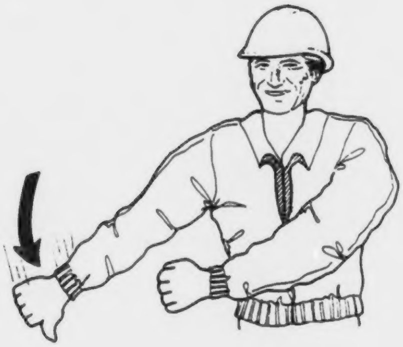


- Raise the boom and lower the load

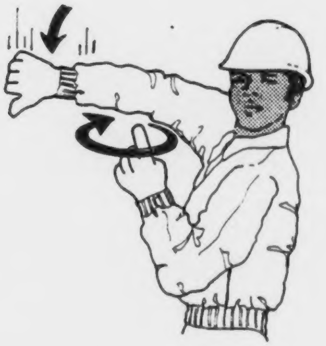


INFORMATION SHEET

- Lower the boom and hold the load

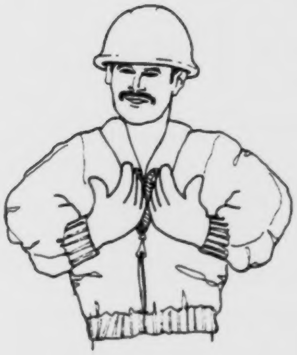


- Lower the boom and raise the load

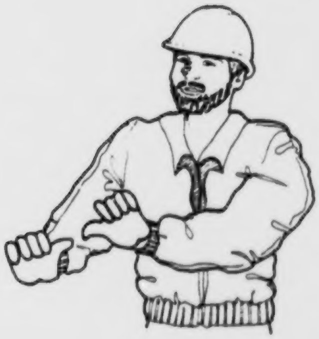


INFORMATION SHEET

- Crowd or extend



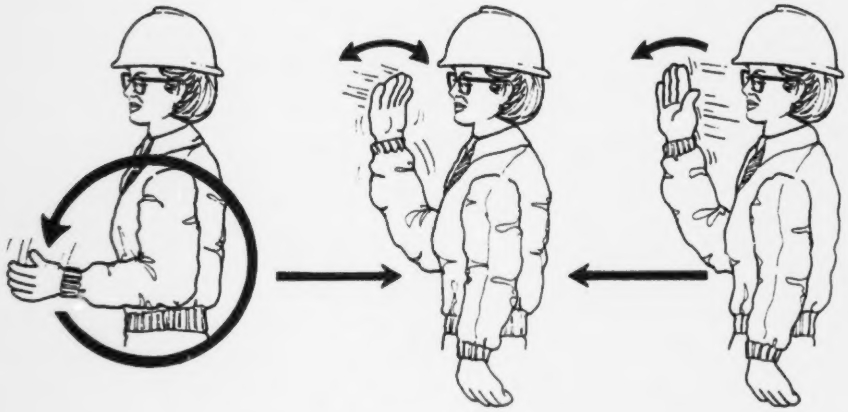
- Rehaul or retract



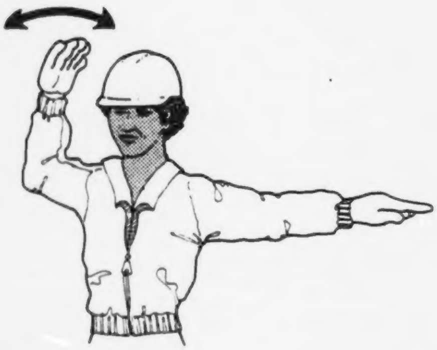
INFORMATION SHEET

8. Identify hand signals used when maneuvering vehicles. (Transparency 4)

- Move

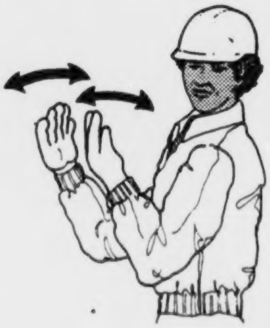


- Turn while moving



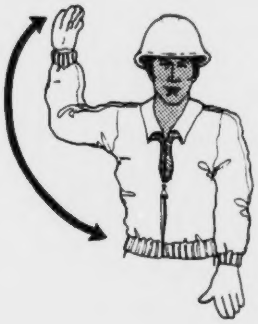
INFORMATION SHEET

- Straighten out



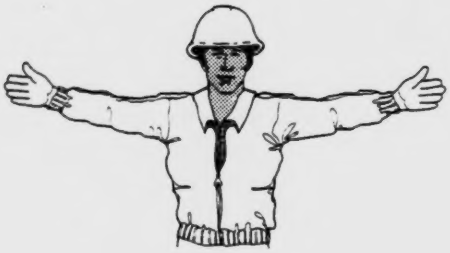
9. Identify line work signals. (Transparency 5)

- Pull up wire

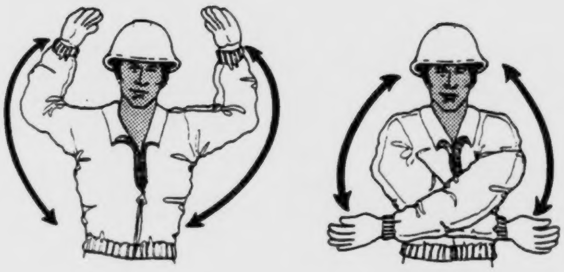


INFORMATION SHEET

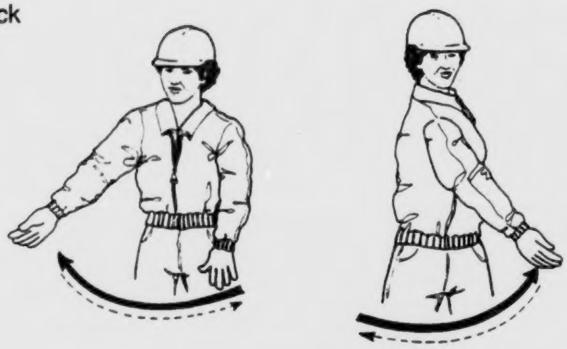
- Stop



- All off



- Slack back



INFORMATION SHEET

10. Select from a list the proper radio procedures.

- Hold microphone three to four inches from mouth

  (NOTE: Many radio systems use a relay unit to transmit and receive messages. Because there is a time delay of one or to seconds required for the relay to operate, wait one or two seconds after keying microphone before giving message.)

- Speak clearly in normal voice tone and volume

- Give your call letters and unit number and the unit number you are calling

  Example: KG-7751 unit 3 to unit 7

- Keep message as brief and precise as possible

- Clear the air when message is complete by giving unit call letters and unit number

  Examples: KG-7751 unit 3 clear with unit 7
  KG-7751 unit 7 clear with unit 3

- Receive calls from other units or the base station by giving your call letters and unit number

  Example: KG-7751 unit 3 to base, over

- Call the base station by giving your unit number and the call letters of the base station

  Example: Unit 3 to KKJ-317

  (NOTE: Always notify the radio dispatcher when you are going to be away from your radio.)

11. State emergency radio procedure.

- Have necessary information ready

  1. Location
  2. Type of accident or emergency
  3. Type of assistance needed

     Example: Ambulance, fire truck, police

- Call dispatcher and give information

INFORMATION SHEET

- Wait for verification

  (NOTE: Be sure the information you have given is clearly understood by the dispatcher.)

12. Select from a list the prohibited uses of the radio.

    - Obscene, profane, or indecent language
    - Music or sound effects
    - Unnecessary or personal conversations
    - Messages not directed to any one person
    - Interference with other communications
    - Using messages with special meanings
    - Selling something
    - Calls to or conversations with stations other than your own
    - Relaying messages for someone other than your system units except in an emergency

13. Match radio code signal numbers to the correct meanings.

    - 10-0 — Caution
    - 10-1 — Unable to copy; change location
    - 10-2 — Signal good
    - 10-4 — Acknowledgement
    - 10-5 — Relay
    - 10-6 — Busy; stand by unless urgent
    - 10-7 — Out of service (give location and/or telephone number)
    - 10-8 — In service
    - 10-9 — Repeat
    - 10-12 — Stand by (stop)
    - 10-20 — Location

INFORMATION SHEET

- 10-21 — Call...by telephone
- 10-22 — Disregard
- 10-23 — Arrived at the scene
- 10-24 — Assignment completed
- 10-25 — Report in person to (meet)...
- 10-30 — Illegal use of radio
- 10-33 — Emergency situation
- 10-41 — Beginning tour of duty
- 10-42 — Ending tour of duty
- 10-51 — Wrecker needed
- 10-52 — Ambulance needed
- 10-66 — Message cancellation
- 10-68 — Dispatch information
- 10-69 — Message received
- 10-74 — Negative
- 10-75 — In contact with
- 10-76 — En route
- 10-77 — ETA (estimated time of arrival)
- 10-78 — Need assistance
- 10-84 — If meeting...advise ETA
- 10-97 — Check (test) signal

14. List factors that are important when using cellular mobile telephones.

(NOTE: Do not operate cellular mobile telephones near electrical blasting caps or near explosives. Disconnect the telephone before jumpstarting/charging the car or truck battery or servicing the vehicle.)

INFORMATION SHEET

- Placing a call

  (NOTE: Similar to home or office telephones. Best to place calls when not moving.)

  1. Turn on telephone
  2. Pick up the handset
  3. Enter code to unlock telephone
  4. Dial the telephone number
  5. Press the "SEND" button to transmit call
  6. Keep message as brief and precise as possible
  7. Replace handset to terminate call

- Receiving a call

  (NOTE: Telephone must be turned on.)

  1. Pick up the handset, or
  2. Press "SEND" for hands free capability

- Limitations

  (NOTE: Must be in area that provides cellular service.)

  1. Local area
  2. Roaming

- Power sources

  1. Internal battery
  2. Car or truck battery

- Directory assistance

  (NOTE: May be used to obtain customer's telephone number.)

  1. Local numbers dial "1411" or "411"

     (NOTE: This may vary by city.)

  2. Long distance numbers dial "1" plus the area code plus 555-1212

INFORMATION SHEET

- FCC rules and regulations

  1. Only authorized FCC technicians can modify the equipment
  2. Obscene, indecent or profane language is not allowed
  3. Transmission of any false or fraudulent signal of distress or communication is not permitted
  4. No person shall willfully or maliciously interfere with or cause interference to any radio communication or signal

- Emergency procedures

  1. Dial "911" to report any emergency

     (NOTE: There is no charge for a "911" call.)

  2. Identify yourself as a cellular mobile telephone user and provide your mobile telephone number
  3. Furnish exact location information
  4. Describe the emergency
  5. Remain at the scene until emergency personnel arrive

BASIC ELECTRICAL THEORY
UNIT 3

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify types and conditions of circuits, discuss the theory of magnetism, and name sources of alternating and direct current. The student should be able to discuss the electron theory and calculate problems dealing with Ohm's law. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with basic electrical theory to the correct definitions.
2. List uses of electricity.
3. Discuss the electron theory.
4. Distinguish between alternating and direct current.
5. Match types of magnets to the correct descriptions.
6. State the law of magnetic poles.
7. Describe magnetic force as it relates to production of electricity.
8. Select from a list characteristics of electromagnetic force.
9. Explain the generation of electricity using magnets.
10. Describe electromagnetic induction.
11. Identify types of circuits.
12. Identify conditions of circuits.
13. Name sources of alternating and direct current.
14. Identify divisions of an electrical system.
15. State the relationship among amperage, resistance, and voltage.
16. Solve problems using Ohm's law.

OBJECTIVE SHEET

17. Calculate for an unknown voltage. (Assignment Sheet 1)
18. Calculate for an unknown amperage. (Assignment Sheet 2)
19. Calculate for an unknown resistance. (Assignment Sheet 3)

BASIC ELECTRICAL THEORY
UNIT 3

INFORMATION SHEET

1. Match terms associated with basic electrical theory to the correct definitions.

- Electricity — Energy that can easily be converted into light, heat,a nd power
- Ampere (A) — Unit of measure used to determine current flow through a conductor
- Volt (V) — Unit of measure of electromotive force
- Watt (W) — Unit of measure used to determine the rate of energy supplied
- Watt-hour — One watt for one hour
- Kilowatt (kW) — One thousand (1000) watts
- Megawatt (MW) — One million (1,000,000) watts
- Gigawatt (GW) — One billion (1,000,000,000) watts
- Kilowatt-hour (kW-h) —1000 watts for 1 hour
- Horsepower — Unit of mechanical power equal to 746 watts of electrical power
- Direct current (DC) — Current that flows in one direction at a continuous rate
- Alternating current (AC) — Current that reverses flow from positive to negative and back to positive at regular intervals

  (NOTE: Sixty-cycle current reverses flow 120 times per second.)
- Circuit — Patch through which electricity flows
- Switch — Device used to open or close a circuit
- Circuit breaker — Device used to open a circuit when current flow is too great

  (NOTE: Circuit breakers may be reset when they have cooled.)
- Fuse — Device used to open a circuit by burning out when current flow becomes to great
- Conductor — Any substance through which electrical current can flow easily

  Example: Wires used in electrical circuits

INFORMATION SHEET

- Insulation — Any substance which will not allow the flow of electrical current in any measurable amount

  Example: The covering on electrical conductors

- Hot wire — Slang for an electrically energized conductor

- Potential — Presence of voltage in a conductor

  (NOTE: Any conductive substance which has a potential will indicate a voltage differential between the substance and ground or another conductor.)

- Ground — Point to connection of a conductor to assist returning current flow to return to the source or to equalize potential

- Neutral — Current-carrying conductor that is connected to a ground

- Common — Current-carrying conductor which may or may not be grounded

- Hertz — Unit of frequency; one complete reversal of alternating current from positive to negative and back to positive

  (NOTE: The term *hertz* means the same as a *cycle per second.*)

2. List uses of electricity.

   - Light
   - Heat
   - Cool
   - Power
   - Communications
   - Control

3. Discuss the electron theory.

   - All things are made of atoms
   - Atoms contain protons and electrons
     1. Nucleus is made up of one or more protons
     2. Electrons orbit the nucleus
   - Electrons in outer orbit of atoms may move from one atom to another

INFORMATION SHEET

- Voltage applied to a conductor causes electrons to move in a closed circuit
- Electron movement in a conductor is current flow

4. Distinguish between alternating and direct current.

- Alternating current
  1. Reverses direction of flow at regular intervals
  2. Transforms easily to higher or lower voltage
  3. Produces an alternating magnetic field
- Direct current
  1. Flows in one direction only
  2. Does not transform easily

5. Match types of magnets to the correct descriptions.

- Natural — Lodestone
- Artificial — Magnet made of iron, nickel, cobalt, or other metals
- Electromagnet — Magnet made with a coil of copper wire wound on a special steel or iron core

6. State the law of magnetic poles.

- Law of magnetic poles — Unlike poles attract; like poles repel

(NOTE: All magnets have a north and south pole.)

7. Describe magnetic force as it relates to production of electricity. (Transparency 1)

- Surrounds a magnet
- Flows from north pole to south pole
- Generates electricity when a bar magnet is moved in and out of a coil of wire
- Produces electricity when a conductor cuts the lines of magnetic force

8. Select from a list characteristics of electromagnetic force.

- A magnetic field is created around a current-carrying conductor
- Electromagnetic force increases as current flow increases

INFORMATION SHEET

- An iron or steel core inside an energized coil will increase the electromagnetic force by concentrating the lines of force

9. Explain the generation of electricity using magnets.

- Occurs when a magnet is moved close to a coil
- Occurs when a coil is moved close to a magnet
- Occurs when a strong bar magnet is moved in and out of a coil (Transparency 2)

10. Describe electromagnetic induction,

- Voltage will be induced in a conductor that moves across an electromagnetic field

  (NOTE: Either the conductor or the magnetic field may move to cause electromagnetic induction.)

- Voltage will be induced in a coil when changing current is applied to an adjacent coil

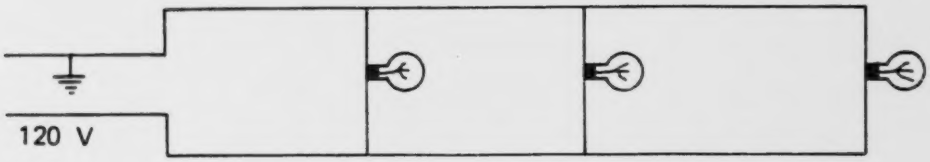
  (NOTE: Voltage will be induced in a conductor which runs parallel to an energized conductor and is close enough to the energized conductor to be in the magnetic field which surrounds it.)

11. Identify types of circuits.

- Parallel circuit (Transparency 3)

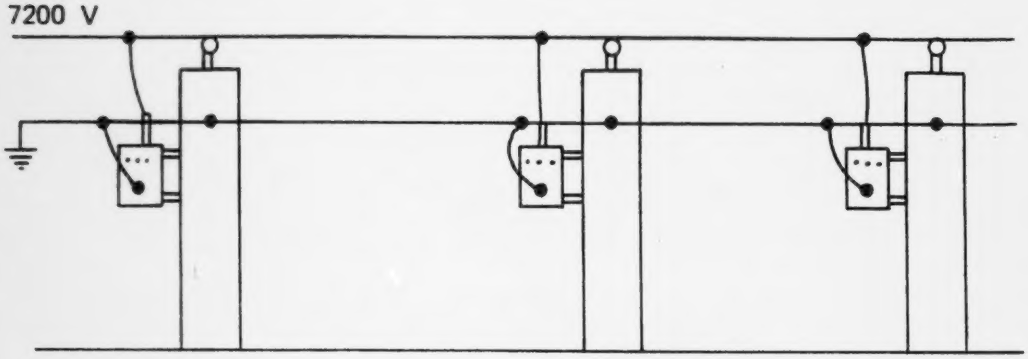
  (NOTE: The voltage will be the same at all points along a parallel circuit.)

  1. Low voltage



INFORMATION SHEET

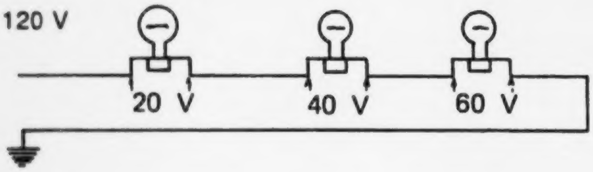
2. High voltage



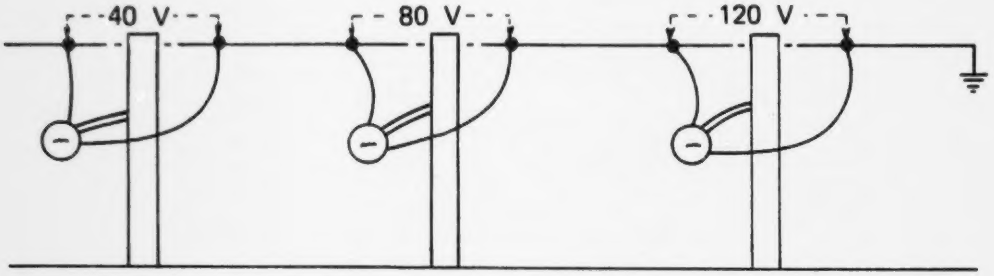
- Series circuit (Transparency 4)

(NOTE: In a series circuit the voltage will drop along the circuit. The total voltage drop in a series circuit will always be equal to the applied voltage.)

1. 120 V

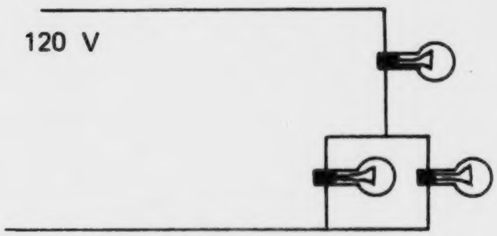


2. 240 V


40 V
80 V
120 V

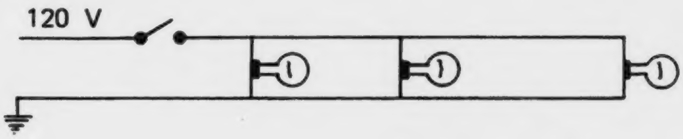
INFORMATION SHEET

- Series-parallel circuit (Transparency 4)

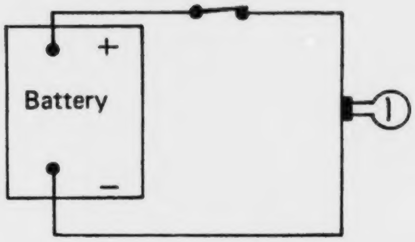


12. Identify conditions of circuits. (Transparency 5)

- Open circuit

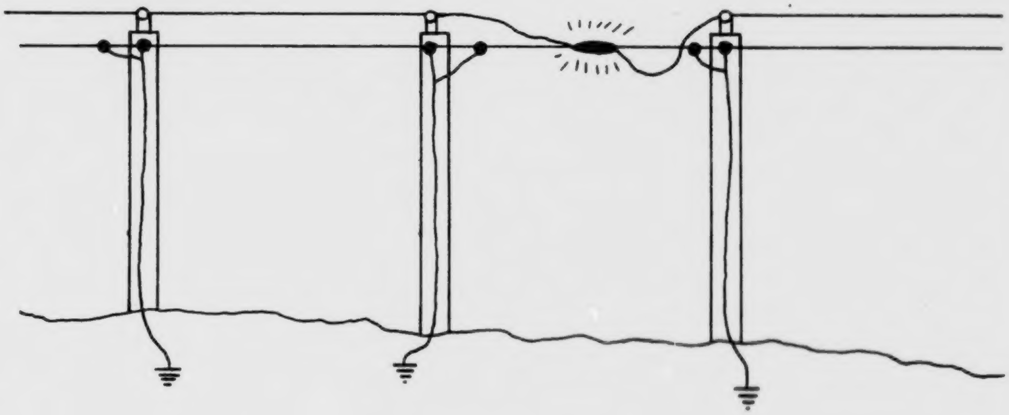


- Closed circuit



INFORMATION SHEET

- Shorted circuit



13. Name sources of alternating and direct current.

    - Alternating current

        1. Generators
        2. Alternators

    - Direct current

        1. Generators
        2. Batteries
        3. Solar cells

14. Identify divisions of an electrical system. (Transparency 6)

    - Generation plant
    - Transformer
    - Transmission lines
    - Substation
    - Distribution lines
    - Secondary lines
    - Service lines

INFORMATION SHEET

- Distribution transformer
- Meter pole

15. State the relationship among amperage, resistance, and voltage.

    - One volt will push one ampere through one ohm of resistance

16. Solve problems using Ohm's law. (Transparency 7)

    (NOTE: In the formula of Ohm's law, I = Amperage, E = Voltage, R = Resistance, and P = Wattage.)

    - To find voltage when amperage and resistance are stated (Assignment Sheet 1)

      Voltage = Amperage × Resistance

      Example: E = I × R
      E = 10 amperes × 12 ohms
      E = 120 volts

    - To find amperage (Assignment Sheet 2)

      1. When voltage and resistance are stated

         Amperage = Voltage ÷ Resistance

         Example: I = E ÷ R
         I = 120 volts ÷ 12 ohms
         I = 10 amperes

      2. When current rating is stated in watts

         Amperage = Wattage ÷ Voltage

         Example: I = P ÷ E
         I = 1440 watts ÷ 120 volts
         I = 12 amperes

    - To find resistance when voltage and amperage are stated (Assignment Sheet 3)

      Resistance = Voltage ÷ Amperage

      Example: R = E ÷ I
      R = 120 volts ÷ 10 amperes
      R = 12 ohms

BASIC ELECTRICAL THEORY
UNIT 3

ASSIGNMENT SHEET 1

OBJECTIVE 17 — CALCULATE FOR AN UNKNOWN VOLTAGE.

Apply the appropriate formula from Ohm's law to find the voltage.

Formula: Amps × Ohms = Volts

Examples:
2 amps × 60 ohms = 120 volts
4 amps × 120 ohms = 480 volts

Problems

	Amps	Ohms		Volts
1.	40	3	=	______________
2.	10	48	=	______________
3.	24	10	=	______________
4.	10	120	=	______________
5.	40	360	=	______________

BASIC ELECTRICAL THEORY
UNIT 3

ASSIGNMENT SHEET 2

OBJECTIVE 18 — CALCULATE FOR AN UNKNOWN AMPERAGE.

Apply the appropriate formula from Ohm's law to find the amperage.

Formula: Volts ÷ Ohms = Amps

Examples:
7200 volts ÷ 720 ohms = 10 amps
120 volts ÷ 8 ohms = 15 amps

Problems

	Volts	Ohms		Amps
1.	14,400	400	=	____________
2.	120	12	=	____________
3.	480	84	=	____________
4.	7,200	60	=	____________
5.	240	32	=	____________

Formula: Watts ÷ Volts = Amps

Example: 1560 watts ÷ 120 volts = 13 amps

Problems

	Watts	Volts		Amps
6.	4,800	240	=	____________
7.	1,560	120	=	____________
8.	2,400	480	=	____________
9.	28,800	14,400	=	____________
10.	3,600	7,200	=	____________

BASIC ELECTRICAL THEORY
UNIT 3

ASSIGNMENT SHEET 3

OBJECTIVE 19 — CALCULATE FOR AN UNKNOWN RESISTANCE.

Apply the appropriate formula from Ohm's law to find the resistance.

Formula: Volts ÷ Amps = Ohms

Examples: 240 volts ÷ 10 amps = 24 ohms
14,400 volts ÷ 50 amps = 288 ohms

Problems

	Volts	Amps		Ohms
1.	7,200	20	=	______________
2.	120	10	=	______________
3.	480	3.2	=	______________
4.	14,400	12	=	______________
5.	240	6	=	______________

ROPE AND RIGGING
UNIT 4

UNIT OBJECTIVE

After completion of this unit, the student should be able to calculate the mechanical advantage of using block and tackle and the safe working load of various ropes. The student should be able to identify various knots and hitches. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with rope and rigging to the correct definitions.
2. Identify parts of a stationary block.
3. List kinds of rope used in line work.
4. Determine the tensile strength of various kinds and sizes of rope.
5. Determine the mechanical advantage of using block and tackle.
6. List uses of various types of rope gear.
7. Apply the formula necessary for the safe working load of various kinds and sizes of ropes when given the tensile strength and safety factory.
8. Identify various knots and hitches.
9. Match various knots and hitches with the correct uses.
10. Identify elements of knots, bends, and hitches.
11. List conditions that damage rope.
12. Calculate the mechanical advantage of using block and tackle. (Assignment Sheet 1)
13. Calculate working load of various ropes. (Assignment Sheet 2)

ROPE AND RIGGING
UNIT 4

INFORMATION SHEET

1. Match terms associated with rope and rigging to the correct definitions.

- Block and tackle — Pulley or combination of pulleys operated with a rope (Transparency 1)
- Sheave — Grooved wheel or pulley
- Becket — Device to which the standing end of the rope in a block and tackle is secured
- Conductors — A substance or thing that conducts electricity

  (NOTE: Good conductors are copper and aluminum.)

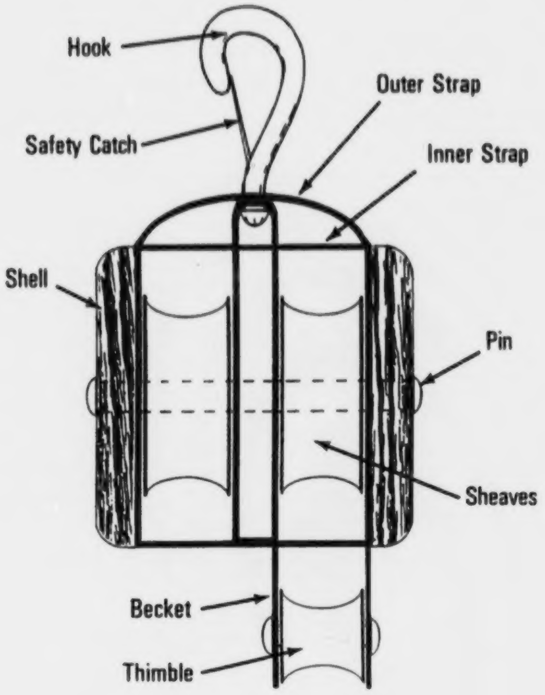
- Fall line — Rope to which pull is applied
- Hand line — Rope used with single sheave block (Transparency 1)
- Insulator — Anything that insulates; a nonconductor

  (NOTE: Good insulators are glass, mica, porcelain, rubber, paper, polyethylene, wood, and fiberglass.)

- Tag line — Rope use to hold conductors away from pole (Transparency 1)
- Reeve — To thread a rope around the sheaves in a set of blocks
- Fair lead — Use of a single line to apply pull more effectively
- Traveling block — End of a block and tackle which is connected to the load to be moved
- Tensile strength — Greatest stress a rope can bear without breaking
- Hitch — Knot used to temporarily secure an object
- Working load — Maximum load that should be applied to a rope
- Sling — Short piece of rope; rope whose ends have been spliced together to form an endless rope; rope with an eye in each end

INFORMATION SHEET

2. Identify parts of a stationary block. (Transparency 2)


Hook
Outer Strap
Safety Catch
Inner Strap
Shell
Pin
Sheaves
Becket
Thimble

(NOTE: Some blocks are made of cast aluminum or stamped steel, but the basic structure will be the same as the wooden shell block. Use nonconductive blocks when working with live lines.)

3. List kinds of rope used in line work.

(NOTE: Keep ropes clean and dry. As ropes become wet, dirty and contaminated, their conductivity increases.)

- Manila
- Nylon
- Dacron
- Polyethylene

(NOTE: Fibers used in making Manila, Nylon, Dacron, and Polyethylene ropes contain moisture as a part of the makeup of the fiber. With increased relative humidity, the fiber moisture content will rise.)

INFORMATION SHEET

- Polypropylene

  (NOTE: Clean dry polypropylene rope is an insulator, all other ropes are conductors.)

4. Determine the tensile strength of various kinds and sizes of rope.

Diameter	Manila	Nylon	Dacron	Polyethylene	Polypropylene
3/16"	450	960	720	700	740
1/4"	600	1,500	1,150	1,200	1,250
5/16"	1,000	2,400	1,750	1,750	1,900
3/8"	1,350	3,400	2,450	2,500	2,700
7/16"	1,750	4,800	3,400	3,400	3,550
1/2"	2,650	6,200	4,400	4,100	4,500
9/16"	3,450	8,000	5,700	5,100	5,400
5/8"	4,400	10,000	7,300	6,000	6,600
3/4"	5,400	14,000	10,000	7,500	8,000
7/8"	7,700	19,000	13,600	9,900	10,750
1"	9,000	24,000	16,500	11,000	12,500
1 1/8"	12,000	31,500	21,600	15,000	17,000
1 1/4"	13,500	36,000	24,400	17,300	19,500

5. Determine mechanical advantage of block and tackle. (Assignment Sheet 1)

- Count the number of sheaves in both the traveling and stationary blocks

  Example: 2 sheaves (stationary block) = 2 sheaves (traveling block) = 4 sheaves

  Theoretical mechanical advantage = 4 to 1

- Divide the weight to be lifted by the number of sheaves

  Example: 800 lbs. ÷ 4 = 200 lbs

  Theoretical pull needed to lift 800 lbs = 200 lbs

- Add 20% to the load for friction loss

  Example: 20% of 800 = 160 lbs
  800 + 160 = 960 lbs

- Divide the total weight to be lifted by the number of sheaves

  Example: 960 lbs ÷ 4 = 240
  Actual pull needed = 240 lbs

- Divide the actual weight to be lifted by the actual pull needed

  Example: 800 ÷ 240 = 3 1/3
  Actual mechanical advantage = 3 1/3 to 1

INFORMATION SHEET

6. List uses of various types of rope gear. (Transparency 1)

   - Block and tackle

     (NOTE: Use nonconductive blocks and ropes when working with live lines.)

     1. Raising and lowering small transformers
     2. Pulling wire
     3. Lifting hot line tools
     4. Lifting for general purposes

   - Sling

     1. Lifting wire reels
     2. Securing transformer to block and tackle
     3. Securing conductor to pole
     4. Lashing for general purposes

   - Hand line

     1. Sending tools and small equipment to line mechanic on pole
     2. Lowering tools and equipment from pole
     3. Lowering line mechanic from pole in rescue situation

        (CAUTION: The rope should not be tied to a vehicle that can be moved.)

   - Tag line — Tying to insulating stick to hold conductor away from pole (Transparency 3)

     (NOTE: An insulating stick is a wood or fiberglass strain insulator with a conductor clamp on one end and a swivel on the other. It is used between the line conductors and the rope tackle when pulling conductors way from structures, when changing insulators, crossarms, or poles.)

7. Apply the formula necessary for a safe working load of various kinds and sizes of ropes when given the tensile strength and safety factor. (Assignment Sheet 2)

   Formula: Tensile strength ÷ safety factor = working load

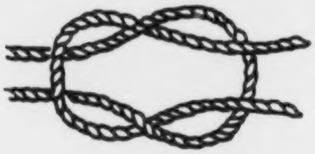
   (NOTE: The following chart shows the working loads which may be applied to new rope. The tensile strength and working load decreases with wear.)

INFORMATION SHEET

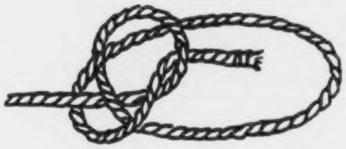
Type of Rope	Tensile Strength	Safety Factor	Working Load
1/2″ nylon	6200 lbs	5	1240 lbs
1/2″ polypropylene	4500 lbs	5	900 lbs
1/2″ dacron	4400 lbs	5	880 lbs
1/2″ polyethylene	4100 lbs	5	820 lbs
1/2″ manila	2650 lbs	5	530 lbs

8. Identify various knots and hitches.

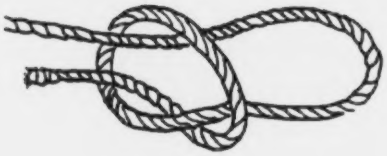
- Square knot



- Bowline

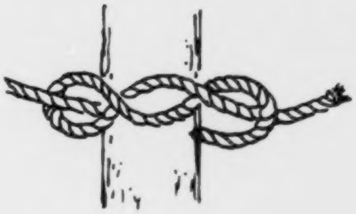


- Slip knot

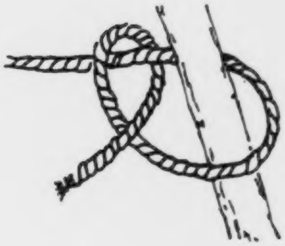


INFORMATION SHEET

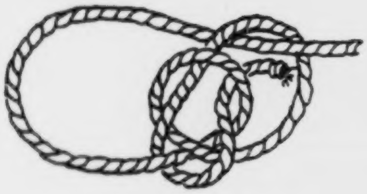
- Timber hitch



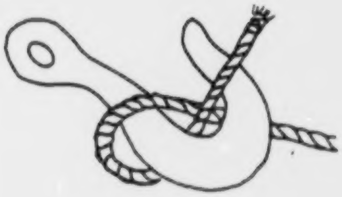
- Half hitch



- Running bowline

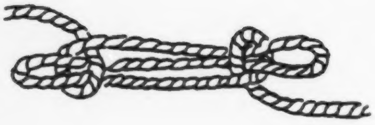


- Blackwall hitch

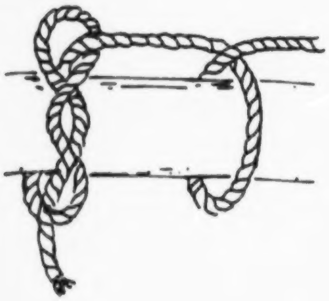


INFORMATION SHEET

- Sheepshank



- Timber hitch with half hitch



9. Match various knots and hitches with the correct uses.

- Square knot — Tying sling lines
- Bowline — Tying for general purposes
- Slip knot — Sending tools and materials up pole
- Timber hitch — Raising poles
- Half hitch — Tying to poles, pipe, or arms temporarily
- Running bowline — Guying top of pole temporarily
- Blackwall hitch — Securing to hook while under steady strain
- Sheepshank — Shortening rope
- Timber hitch with half hitch — Sending crossarm up pole

INFORMATION SHEET

10. Identify elements of knots, bends, and hitches. (Transparency 3)

    - Bight
    - Overhand loop
    - Underhand loop
    - Running end
    - Whipping
    - Round turn
    - Turn
    - Standing part

11. List conditions that damage rope.

    - Improper knots or hitches
    - Vehicle or foot traffic over rope
    - Incorrect block and sheave size
    - Overloading or sudden jerks
    - Exposure to acid, fumes, or oil
    - Dragging rope over sharp objects
    - Permitting rope to freeze when wet
    - Exposure to extreme heat

    (NOTE: Manila rope is subject to mildew and rot and therefore should not be stored when wet.)

ROPE AND RIGGING
UNIT 4

ASSIGNMENT SHEET 1

OBJECTIVE 12 — CALCULATE THE MECHANICAL ADVANTAGE OF USING BLOCK AND TACKLE.

Calculate the actual mechanical advantage of a block and tackle if the stationary block has three sheaves, the traveling block has three sheaves, and the load to be lifted weighs 600 pounds.

Total number of sheaves =
Theoretical advantage (total number of sheaves to 1) =
Theoretical pull needed (actual load ÷ total number of sheaves) =
Friction loss (20% of actual load) =
Weight to be lifted plus friction loss (actual load + 20% of actual load) =
Actual pull needed (load + friction loss ÷ number of sheaves) =

Actual mechanical advantage (actual load ÷ actual pull needed) =
Show your work.

ROPE AND RIGGING
UNIT 4

ASSIGNMENT SHEET 2

OBJECTIVE 13 — CALCULATE WORKING LOAD OF VARIOUS ROPES.

Calculate the working load of the following ropes, using a safety factor of 5.

1. Polypropylene rope with 4500 lbs tensile strength

   Safe working load =

2. Nylon rope with 36,000 lbs tensile strength

   Safe working load =

3. Dacron rope with 4400 lbs tensile strength

   Safe working load =

4. Manila rope with 2650 lbs tensile strength

   Safe working load =

OVERHEAD CONSTRUCTION
UNIT 5

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify hand tools, construction equipment, and various connectors and match them to their specific uses. The student should be able to select from a chart the proper depth to set a pole and state procedures for installing a pole key and ground rod. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with overhead construction to the correct definitions.
2. Match materials commonly used in overhead construction to their specific uses.
3. Identify hand tools commonly used in overhead construction.
4. Match hand tools to their specific uses.
5. Identify overhead construction tools.
6. Match overhead construction tools to their specific uses.
7. List elements of overhead construction.
8. List equipment used in overhead construction.
9. Match equipment commonly used in overhead construction to their specific uses.
10. Select from a chart the correct depth to set poles of varying lengths.
11. List methods used to properly sag conductors.
12. Identify various types of connectors used in overhead construction.
13. Match types of construction to the correct descriptions.
14. List steps to properly install a pole key.
15. State correct procedure for installing a ground rod.
16. Arrange in order the steps to follow when framing a pole.
17. Identify various structures used in transmission line construction.

OVERHEAD CONSTRUCTION
UNIT 5

INFORMATION SHEET

1. Match terms associated with overhead construction to the correct definitions.

   - Overhead stub — Pole used to elevate guy wire over roadways or obstructions (Transparency 1)
   - Guy strand — Strong steel wire used to hold against conductor strain between pole and anchor
   - Dead end — Place in the line where the conductor is connected to an attachment and may or may not continue to other poles (Transparency 1)
   - Pole brand — Marking found on pole which gives the kind of wood, the date pole was treated, the manufacturer, and the length and class of pole (Transparency 2)
   - Pole gain — Area at the top of a pole which is planed and drilled for crossarm or hardware attachment (Transparency 2)
   - Stub pole — Short length of pole strapped and bolted to an existing pole for support (Transparency 3)
   - Framing — Removing bark, trimming, gaining, boring holes, and attaching grounds and hardware
   - Canting — Aligning the holes in a pole with the conductor or at an angle to the conductor
   - Rake — To lean a pole against conductor strain (Transparency 4)
   - Piking — Using a long, round pole, with a pointed metal spike on one end to plumb or hold a pole straight while setting
   - Pole key — Section of a pole or a treated plank used to brace a pole (Transparency 4)
   - Sag — Distance between a straight line and where the conductor is recommended to be hung (Transparency 5)
   - Dolly — Pulley mounted on a crossarm or pole to string conductor through when stringing long runs of conductor
   - Lagging — Soft wood planks nailed or strapped across conductor reels to protect the conductor (Transparency 6)

INFORMATION SHEET

- Distribution line — Line which carries 2,300 to 34,500 volts of power throughout urban and rural areas
- Transmission line — Line which carries power over great distances between generation plant and substations

2. Match materials commonly used in overhead construction to their specific uses.

   (NOTE: A partial list of commonly used materials is given below. It does not contain all materials used in overhead construction.)

   - 5/8″ machine bolt — Attaches hardware and equipment to poles
   - 3/4″ machine bolt — Used in heavier distribution and transmission line construction and for pole stubbing
   - 1/2″ machine bolt — Used to bolt heavy-duty crossarm braces to crossarm
   - 3/8″ carriage bolt — Used to bolt standard crossarm braces to crossarm
   - Double arming bolt — Used to bolt crossarms together when two or more crossarms are used
   - Eye bolt — Used where a dead end in the primary or neutral is constructed
   - Thimble eye bolt — Used with guy wire on overhead guys
   - Eye nut — Used on the back side of an eye bolt when a double dead end is constructed
   - Upset bolt — Used in the neutral position on primary structure for attaching the neutral conductor
   - Double upset bolt — Used to hold conductor an extended distance from pole
   - Dead-end shoe — Used to secure conductor at a dead end
   - Clevis — Used to hold a spool insulator
   - Spool insulator — Used with both large and small clevises for service dead ends and neutral dead ends and on upset bolts
   - Wire holder — Used for screwing into wood or clamping around pipe

INFORMATION SHEET

- Square washer — Used with all bolts when nut does not tighten against other hardware
- Anchor shackle — Used to connect eye bolts or eye bolt and eye nut together
- Suspension insulator (bell) — Used to dead end or suspend conductor on angle poles or is hung below crossarm to suspend conductor on higher voltage systems
- Anchor — Used with a rod for attaching guy wire to hold against conductor strain
- Insulator pin — Used on a crossarm to attach an insulator
- Connector — Connects conductors together which are not under strain
- Locknut — Used on all bolts
- Pole top pin — Bolts to top of pole to hold insulator
- Butt plate — Fastens to the bottom of a pole for a ground

3. Identify hand tools commonly used in overhead construction. (Transparency 12)
    - Line technician's pliers
    - Ratchet wrench
    - Screwdriver
    - Adjustable wrench
    - Skinning knife
    - Line technician's hammer
    - Folding wood rule
4. Match hand tools to their specific uses.
    - Line technician's pliers — Cuts and serves soft wire
    - Screwdriver — Drives and removes screws
    - Line technician's hammer — Drives lag screws and steeples
    - Ratchet wrench — Loosens and tightens connectors, bolts, and nuts
    - Adjustable wrench — Tightens nuts and connectors
    - Skinning knife — Removes insulation
    - Folding wood rules — Measures spacing for material

INFORMATION SHEET

5. Identify overhead construction tools. (Transparencies 13 and 14)

- Pulling grips
    1. Wire grip
    2. Guy grip
    3. Hot line wire grip
- Hoists
    1. Chain hoist
    2. Cable hoist
    3. Insulated strap hoist
    4. Insulating stick
- Cant hook
- Pole carrying hook
- Pole jack
- Anchor auger
- Digging shovel
- Digging spoon
- Tamp
- Pole framing gin
- Transformer gin
- Bolt cutters
- Load binder and chain
- Compression tool

  (NOTE: Properly adjust *all* compression tools.)
- Signs, cones, paddles and vest

  (NOTE: Use while working near any roadway.)

INFORMATION SHEET

6. Match overhead construction tools to their specific uses.

   - Pulling grip — Attaches to conductor and is used with hoist or block and tackle to pull conductor or guy wire
   - Hoist — Pulls tension on conductor or guy wire
   - Cant hook — Turns poles
   - Pole carrying hook — Carries poles
   - Pole jack — Pulls or straightens poles
   - Anchor auger — Digs anchor holes
   - Digging shovel — Digs pole holes
   - Digging spoon — Removes loose dirt from pole holes
   - Tamp — Packs soil around poles or on anchors
   - Pole framing gin — Elevates and holds pole while framing material is being installed
   - Transformer gin — Attaches to pole to hold block and tackle for lowering or raising transformer
   - Bolt cutters — Cut guy wire and heavy conductor
   - Load binder and chain — Binds poles to truck or pole trailer
   - Compression tool — Crimps sleeves and connectors

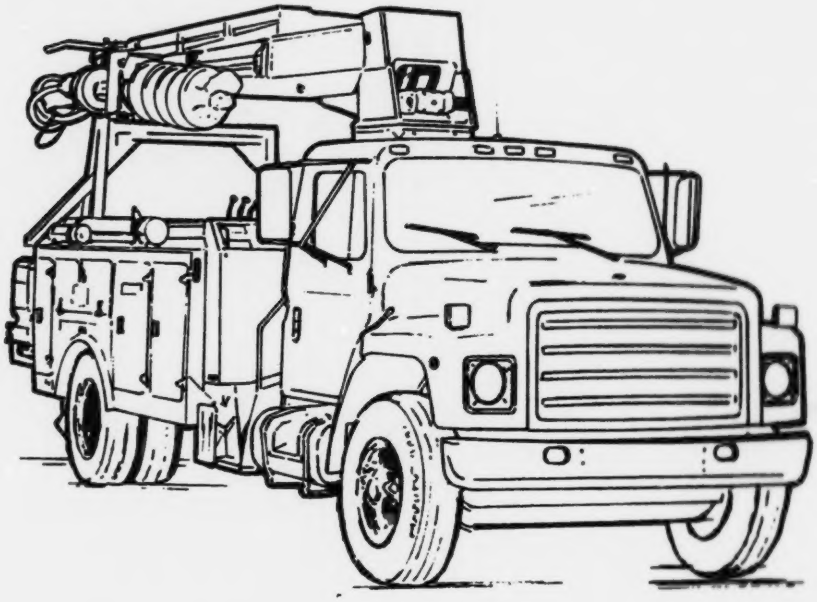
7. List elements of overhead construction.

   - Pole loading, hauling, framing, setting, and removing
   - Anchor setting
   - Guy make-up and pulling
   - Conductor stringing, laying up, sagging, and tying in

INFORMATION SHEET

8. List equipment used in overhead construction.

   - Hole digger derrick



   - Pole truck and trailer

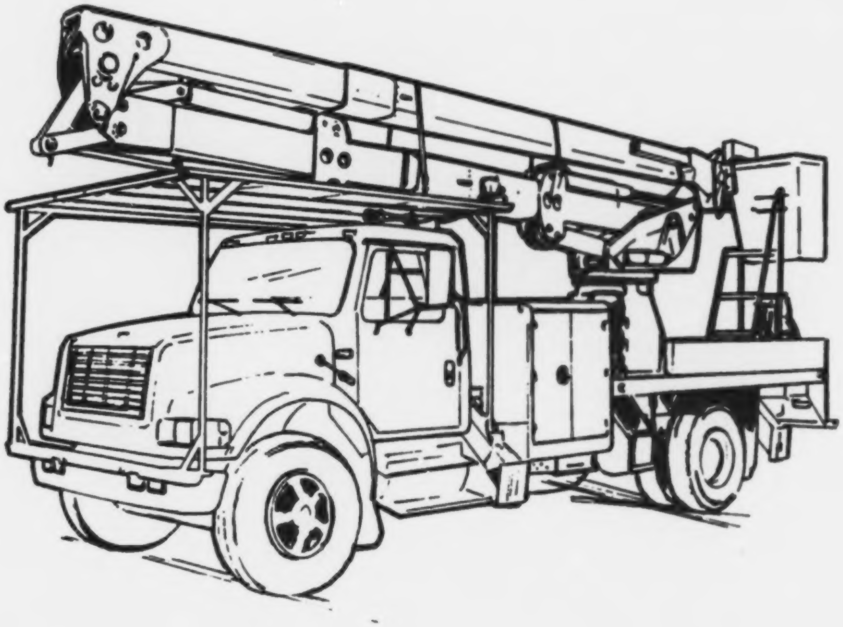
     (NOTE: Ask your instructor to locate a photograph or drawing.)

INFORMATION SHEET

- Conductor-stringing truck

  (NOTE: Ask your instructor to locate a photograph or drawing.)

- Basket truck



INFORMATION SHEET

9. Match equipment commonly used in overhead construction to their specific uses.

   - Hole digger derrick — Digs pole and anchor holes; sets and pulls poles
   - Pole truck and trailer — Carry poles and materials to job site
   - Conductor-stringing truck and trailer — Carry reels of primary and service conductor to job site
   - Basket truck — Assists line technician in reaching and working near energized conductors

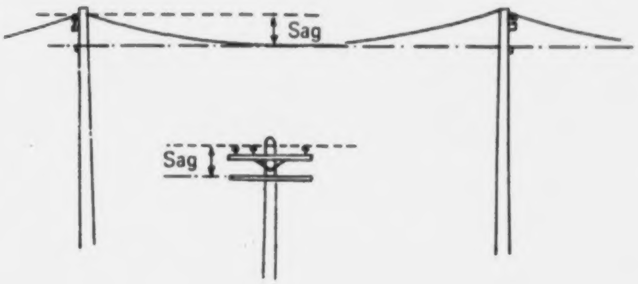
10. Select from a chart the correct depth to set poles of varying lengths.

Length of Pole (feet)	Setting in Soil (feet)	Setting in All Solid Rock (feet)
20	4.0	3.0
25	5.0	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0
65	8.5	
70	9.0	
75	9.5	
80	10.0	
85	10.5	
90	11.0	
95	11.0	
100	11.0	

Pole setting depth for lengths of 65 feet or more may be decreased from soil setting depth by two feet when pole is set in solid rock.

11. List methods used to properly sag conductors.

   - Sighting



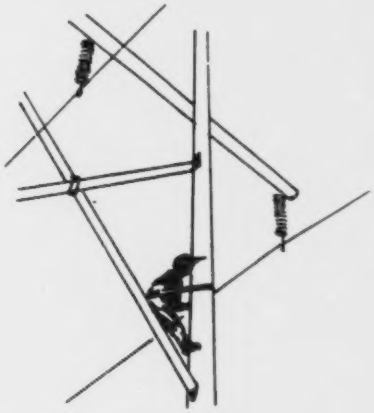
INFORMATION SHEET

- Return wave (Transparency 15)

  (NOTE: The return wave method of checking sag requires a sagging table or chart which indicates sag according to the time required for an induced wave to travel from one support to another and return three, five, ten, or fifteen times. Sag cannot be checked by this method if there is a sleeve in the span.)

- Transit

  (NOTE: When span lengths are very long, a person cannot see the conductor in mid-span and the next support. A transit is secured and leveled on a support and enables the person sagging the conductor to see the greater span lengths.)

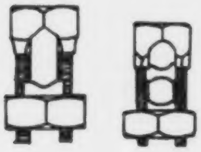


- Dynamometer (Transparency 16)

  (NOTE: A dynamometer is used to measure the tension of a conductor rather than the amount of sag.)

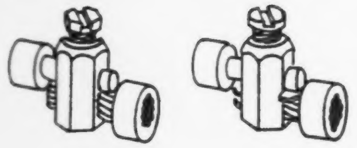
12. Identify various types of connectors used in overhead construction.

    - Split bolt

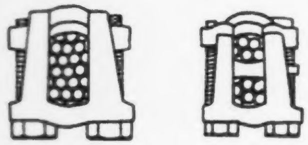


INFORMATION SHEET

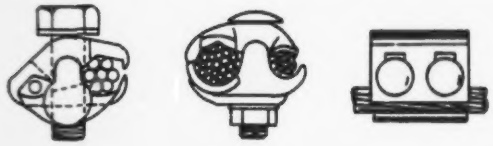
- Service entrance



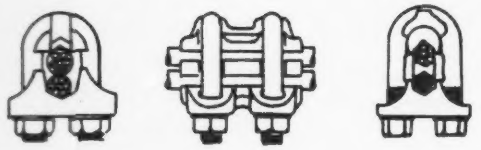
- Two bolt



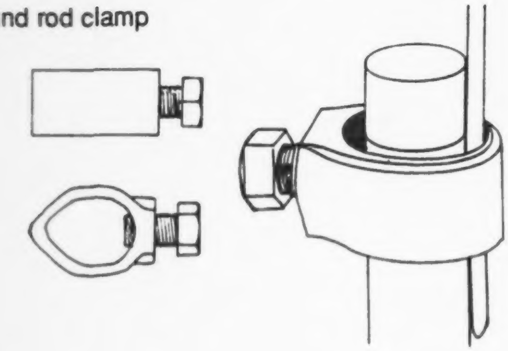
- Center bolt



- U-bolt clamp

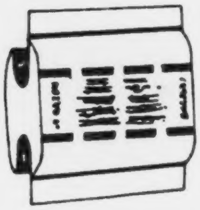


- Ground rod clamp

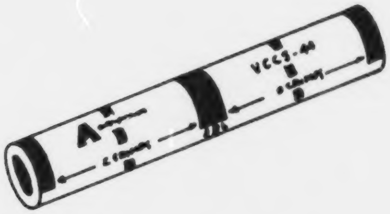


INFORMATION SHEET

- Compression fitting



- Compression sleeve



(NOTE: The manufacturer's recommendations should be followed for conductor and sleeve size. Connectors A, B, C, and E are shown with and without a spacer between the conductors. The connectors with the spacer are used when connecting copper and aluminum.)

13. Match types of construction to the correct descriptions.

(NOTE: The following grades of construction with a "V" prefix are 14,400/24,970-volt construction. Any construction grade without the "V" designates 7200/12,470-volt construction.)

- VA — One primary conductor with one neutral conductor

  (NOTE: Type A construction is usually referred to as *single-phase construction.*)

- VB — Two primary conductors with one neutral conductor

  (NOTE: Type B construction is sometimes referred to as *V-phase construction.*)

- VC — Three primary conductors with one neutral conductor

  (NOTE: Type C construction is usually referred to as *three-phase construction.*)

- VDC — Six primary conductors with one neutral conductor

  (NOTE: Type DC construction is usually referred to as *double circuit construction.)*

INFORMATION SHEET

14. List steps to properly install a pole key.

    - Dig trench the required length at a right angle to conductor strain
    - Insert pole key in trench so that top of key is 12″ below ground

    (NOTE: The pole key should fit against pole and trench so that key is next to undisturbed soil.)

15. State correct procedure for installing a ground rod.

    - Dig trench 14″ deep and 30″ long parallel with overhead conductors
    - Drive ground rod into undisturbed soil 2′ from pole

    (NOTE: The top of the ground rod must be a minimum of 12″ below ground.)

16. Arrange in order the steps to follow when framing a pole.

    (NOTE: All line technicians, operators and groundworkers should comply with information in specifications book.)

    - Roll pole onto framing gin with cant hook
    - String and steeple pole ground to pole
    - Place steeples 6″ apart from ground level to 8′ above ground and 8′ from top of pole
    - Place steeples 2′ apart on remainder of pole
    - Install required hardware with square washers and locknuts on all bolts
    - Install crossarm, if required
    - Check pole ground for clearance between pole ground and hardware

    (NOTE: The pole ground should clear all hardware at least 2″ to prevent radio and television interference from arcing between the pole ground and hardware.)

17. Identify various structures used in transmission line construction. (Transparencies 18-21)

    - 69 kV single pole double circuit
    - 69 kV single pole single circuit
    - 69 kV two pole single circuit
    - 115 kV H-frame

INFORMATION SHEET

- 230 kV H-frame
- 69 kV-230 kV steel pole single and double circuit
- 115 kV steel tower single circuit
- 345 kV steel tower double circuit

UNDERGROUND DISTRIBUTION CONSTRUCTION
UNIT 6

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify equipment and materials used in underground construction and be able to observe precautions in handling and splicing cable. The student should be able to make a cable splice. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with underground construction to the correct definitions.
2. Identify equipment used in underground construction.
3. Match various types of equipment to the specific uses.
4. List general requirements for underground construction.
5. Arrange in order the correct procedure for installing cable.
6. List precautions to observe when handling underground cable.
7. Select from a list methods of marking cable for identification.
8. List methods used to locate and identify a utility ditch.
9. Identify equipment used to terminate primary cable on a pole.
10. State the requirement for grounding underground equipment.
11. List hazards which may be encountered in underground construction.
12. List precautions to observe when splicing or terminating cable.
13. Select from a list the tools used in underground construction.
14. Make a proper splice in secondary cable. (Job Sheet 1)
15. Make a proper splice in primary cable. (Job Sheet 2)

UNDERGROUND DISTRIBUTION CONSTRUCTION
UNIT 6

INFORMATION SHEET

1. Match terms associated with underground construction to the correct definitions.

- Service cable — Underground cable which runs from transformer or pedestal to metering point (Transparency 1)
- Secondary cable — Heavy underground cable which runs from transformer to pedestal (Transparency 1)
- Primary cable — High voltage cable which runs from source of power to transformer or protective equipment (Transparency 2)
- Riser — Length of conduit installed on a pole or on a building to protect underground cable above the ground (Transparency 3)
- Pedestal — Buried or partially buried enclosure used as a point of connection for secondary and service cable (Transparency 4)
- Connector block — Aluminum or copper block used to connect conductors (Transparency 4)
- Terminator — Unit installed on the ends of primary cable (Transparency 5)
- Concentric neutral — Conductor spiraled around insulated conductor or conductors in both high and low voltage cable (Transparency 1, Transparency 2)

  (NOTE: The concentric neutral may be either a round wire or flat strap conductor.)
- Stress — Electric flux lines which concentrate at the ends of high voltage cable and deteriorate cable insulation (Transparency 6)

  (NOTE: Stress will also concentrate at a splice which has not been protected with stress relief tape or at a void in the cable insulation.)
- Stress cone — Cone or tape designed to disperse electric flux lines (Transparency 7)
- Semi-conductor — Solid material that has electrical characteristics between that of a conductor and an insulator and is used for stress control
- Underground distribution system — Area of housing or business fed by underground power lines (Transparency 8)
- Switching cabinet — Metal enclosure which contains equipment for changing circuit feeds or loads from one circuit to another (Transparency 9)

INFORMATION SHEET

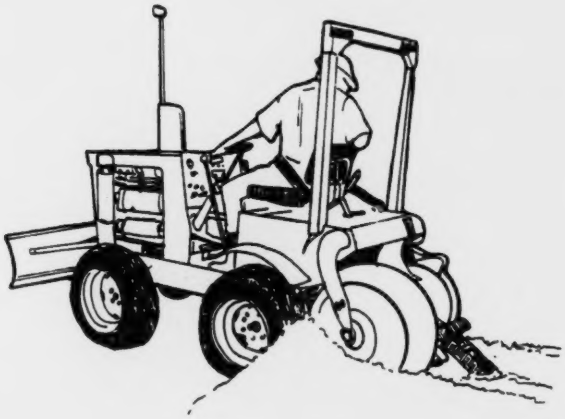
- Vault — Fiber or concrete enclosure installed below grade to house transformer or switching gear (Transparency 9)
- Feed-through bushing — Bushing used on transformers and switching gear for connecting elbow terminators (Transparency 9)

  (NOTE: It is often called a "flower pot.")

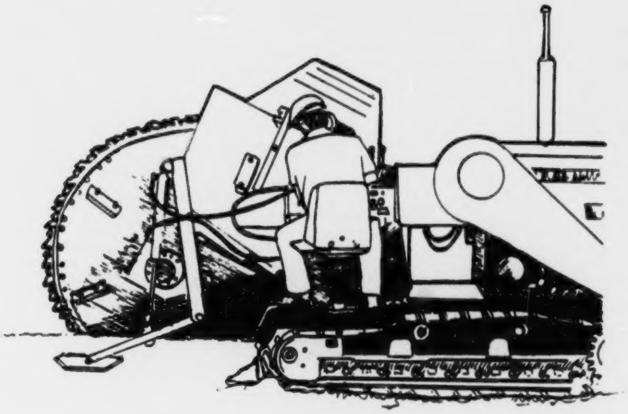
2. Identify equipment used in underground construction.

- Small trencher with backfill blade

  (NOTE: Operator is wearing a seatbelt and the trencher is equipped with a roll bar.)

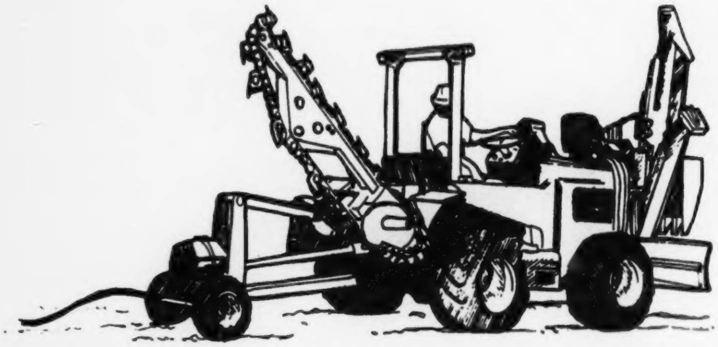


- Large trencher with frost- and rock-cutting teeth

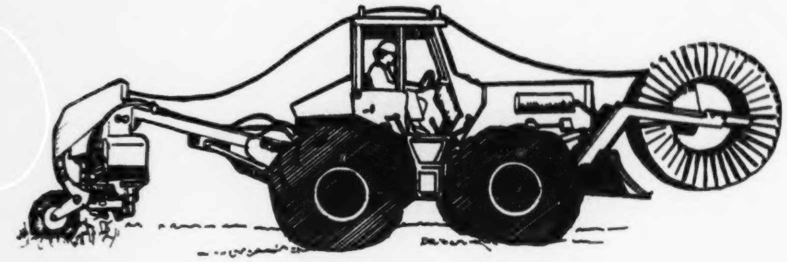


INFORMATION SHEET

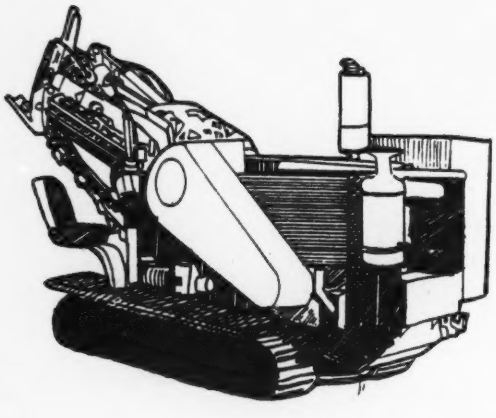
- Medium-sized trencher with cable plow attached



- Large cable plow with cable reel attachment

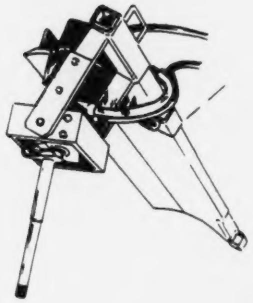


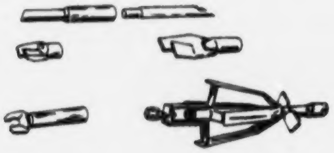
- Large track-mounted trencher

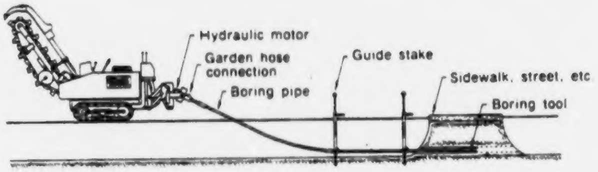


INFORMATION SHEET

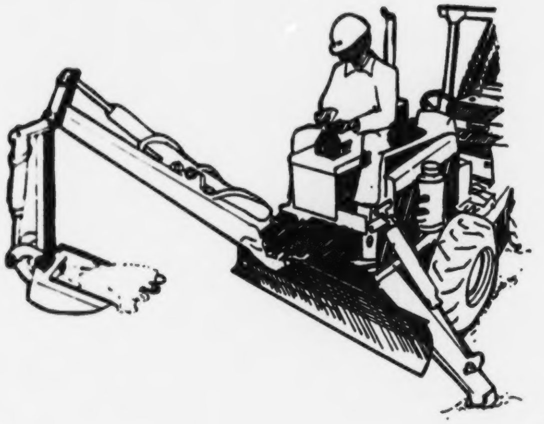
- Boring machine and boring tools



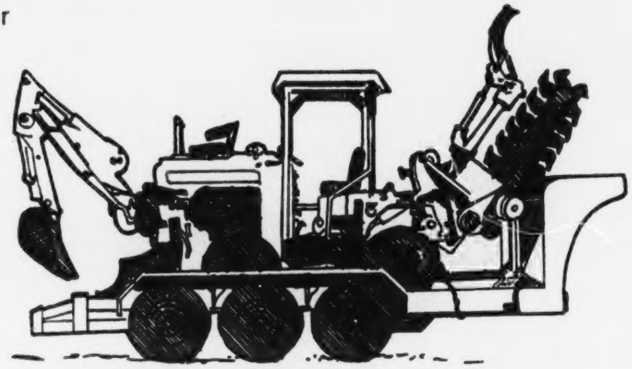



Hydraulic motor
Garden hose connection
Boring pipe
Guide stake
Sidewalk, street, etc
Boring tool

- Backhoe attachment



- Equipment trailer



INFORMATION SHEET

3. Match various types of equipment to the specific uses.

   - Small trencher with backfill blade — Trenches and backfills on short cable runs where great depth is not needed
   - Large trencher with frost- and rock-cutting teeth — Trenches in frozen ground and in rocky structures
   - Medium-sized trencher with cable plow — Plows in cable where great depth is not needed or trenches when greater depth is necessary
   - Large cable plow with cable reel attachment — Plows in cable at great depth in open country where pipelines or other underground utilities are not present
   - Large track mounted trencher — Trenches in muddy or sandy areas where long cable runs are needed
   - Boring machine and boring tools — Bores and reams out holes under streets and paved areas
   - Hydraulic jackhammer — Breaks up concrete or hard rock
   - Hydraulic pipe pusher — Pushes large diameter pipe under streets and paved areas
   - Backhoe attachment — Digs out large areas for working room
   - Equipment trailer — Transports equipment to and from job sites

4. List general requirements for underground construction.

   - All work should be done in a thorough and skillful manner.
   - All work should be done in accordance with plans and specifications.
   - All work should meet or exceed the National Electrical Safety Code requirements.

5. Arrange in order the correct procedure for installing cable.

   - Lay conduit under streets
   - Lay out cable from moving vehicle
   - Inspect cable as it is removed from reel
   - Remove any objects from trench that might damage cable
   - Lay cable in trench by hand
   - Backfill

INFORMATION SHEET

6. List precautions to observe when handling underground cable.

   - Handle carefully to avoid damage

     (NOTE: When using equipment to load or unload reels of cable, do not allow the equipment, winch line, or bars to contact the cable.)

   - Avoid excessive bending

     (NOTE: Cable should not have a bend which measures less than twelve times the diameter of the cable on the inside of the bend.)

   - Keep ends of cable sealed against moisture
   - Do not drag cable

7. Select from a list methods of marking cable for identification.

   (NOTE: It is extremely important that cable be marked properly for further identification. The cable should be marked as soon as it has been reeled out to avoid mismarking when more than one cable has been laid.)

   - Embossed plastic tape
   - Imprinted plastic tags
   - Corrosion-resistant metal tags
   - Colored plastic tape

8. List methods used to locate and identify a utility ditch.

   - Above-grade stake driven near ditch with name of utility attached
   - Plate inscribed with utility name placed over cable and flush with ground
   - Electronic voltage detector if cable is energized
   - Plastic tape inscribed with Caution: Electric Power Cable Below buried near surface of ditch
   - Spray paint marker

INFORMATION SHEET

9. Identify equipment used to terminate primary cable on a pole. (Transparency 3)

    - Lightning arrester
    - Fuse cut-out
    - Terminator and bracket
    - Eye bolt
    - Shackle
    - Wire sock
    - Riser
    - Grounding bushing

10. State the requirement for grounding underground equipment.

    - All neutral conductors and groundable parts shall be interconnected.

      (NOTE: A telephone system which has underground lines near an electrical system may require a connection to the electrical system neutral.)

11. List hazards which may be encountered in underground construction.

    - Loop feed system
    - Equipment that has not been properly grounded
    - Regenerated charge that can exist on high voltage undergrounded cable

      (NOTE: Primary cable acts as a capacitor and may contain enough voltage to seriously injure anyone who carelessly handles undergrounded cable.)

    - Other utilities

12. List precautions to observe when splicing or terminating cable.

    - Ground the cable being repaired
    - Use portable cover or shelter
    - Keep material and cable dry
    - Keep hands, material, and cable clean

INFORMATION SHEET

- Clean surfaces with denatured alcohol
- Lubricate contacting surfaces with silicone grease

  (NOTE: Silicone grease is a good insulative material as well as a lubricant. It also helps seal out moisture.)
- Follow manufacturer's specifications

13. Select from a list the tools use din underground construction.

- Cable cutters
- Insulation removing tool
- Compression tool
- Hand shovel
- Trench cleaning spoon

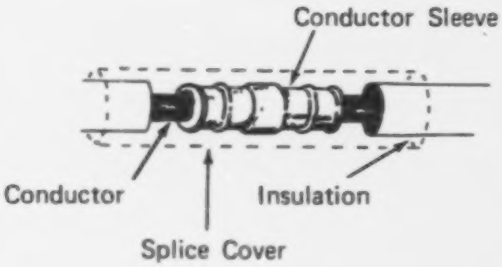
UNDERGROUND DISTRIBUTION CONSTRUCTION
UNIT 6

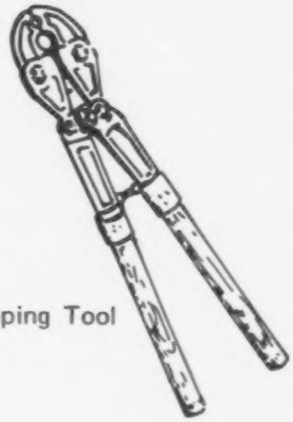
JOB SHEET 1

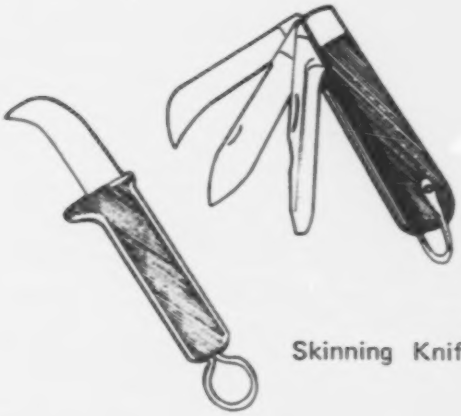
OBJECTIVE 14 — MAKE A PROPER SPLICE IN SECONDARY CABLE.

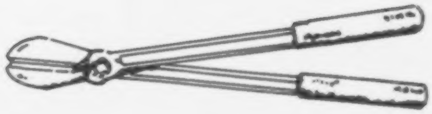
1. Tools and materials
   - Rule
   - Insulation removing tool
   - Conductor sleeve
   - Crimping tool
   - Splice cover

     (NOTE: There are several different types of splice covers which are suitable for secondary splicing.)
   - Skinning knife
   - Cable cutter


Conductor Sleeve
Conductor
Insulation
Splice Cover


Crimping Tool

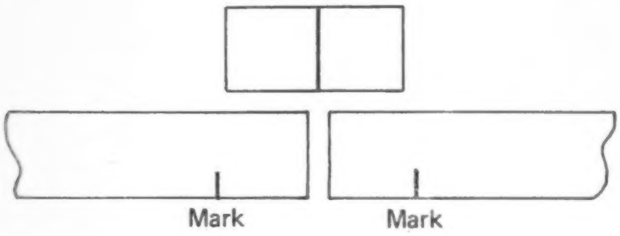

Skinning Knife


Cable Cutter

JOB SHEET 1

2. Procedure

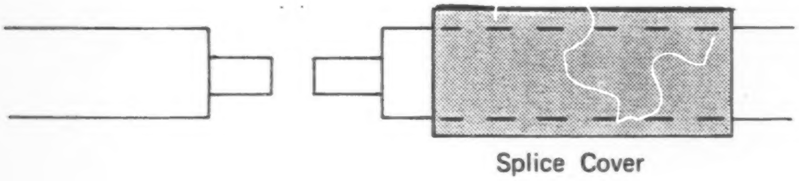
- Gather tools and materials
- Measure and mark distance from end of conductor that insulation is to be removed for conductor sleeve



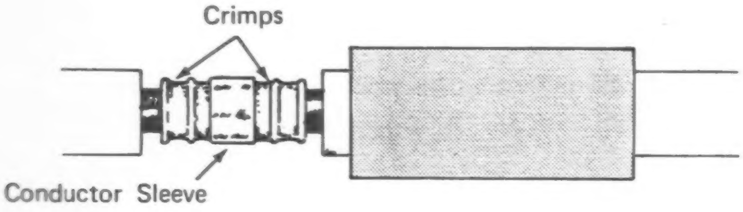
- Remove insulation to mark

  (NOTE: Care should be taken to avoid damage to conductor when removing insulation.)

- Slide splice cover over conductor

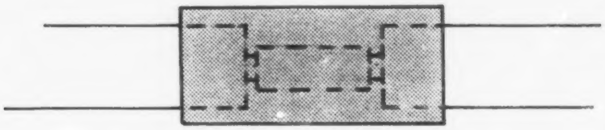

Splice Cover

- Install and crimp conductor sleeve


Crimps
Conductor Sleeve

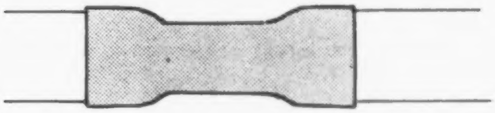
JOB SHEET 1

- Slide splice cover to center of conductor sleeve



- Apply heat to splice cover to shrink to fit conductor insulation

  (NOTE: Apply epoxy, Scotchkote®, or other suitable sealer if a heat-shrink splice cover is not used.)



UNDERGROUND DISTRIBUTION CONSTRUCTION
UNIT 6

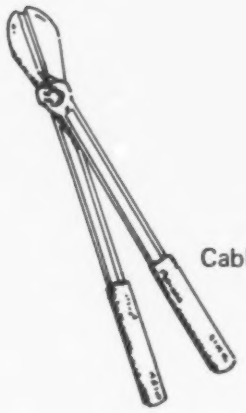
JOB SHEET 2

OBJECTIVE 15 — MAKE A PROPER SPLICE IN PRIMARY CABLE.

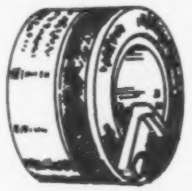
1. Tools and materials

   - Rule
   - Crimping tool

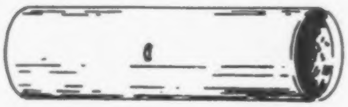
     (NOTE: Use the appropriate dies and properly adjust the tool.)
   - Insulation removing tool
   - Cable cutter
   - Primary cable splice kit



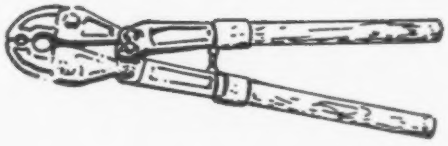
Cable Cutter



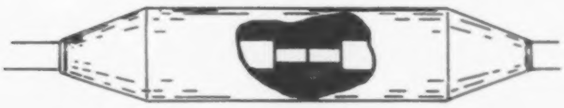
Insulation Removing Tool



Conductor Sleeve



Crimping Tool

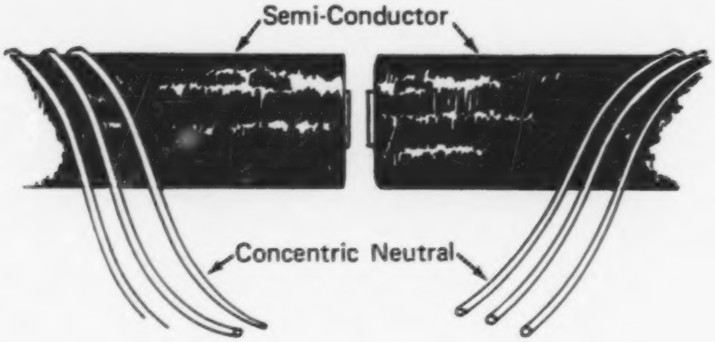

Sleeve
Insulation
Semi-Conducting Material

JOB SHEET 2

2. Procedure

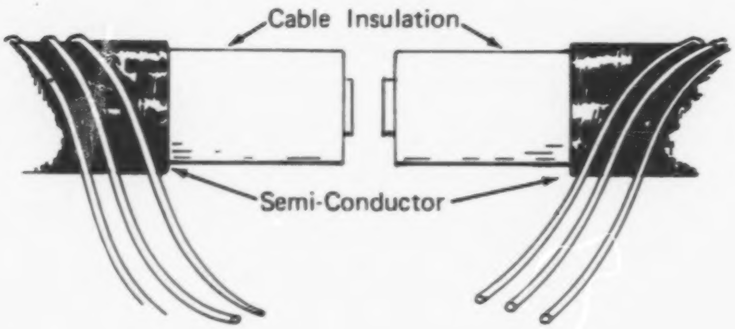
- Remove concentric neutral far enough to install splice

  (NOTE: Do not cut neutral wire.)


Semi-Conductor
Concentric Neutral

- Remove outer semi-conductor to distance specified by splice manufacturer

  (NOTE: When removing outer semi-conductor, do not cut or nick the insulation.)

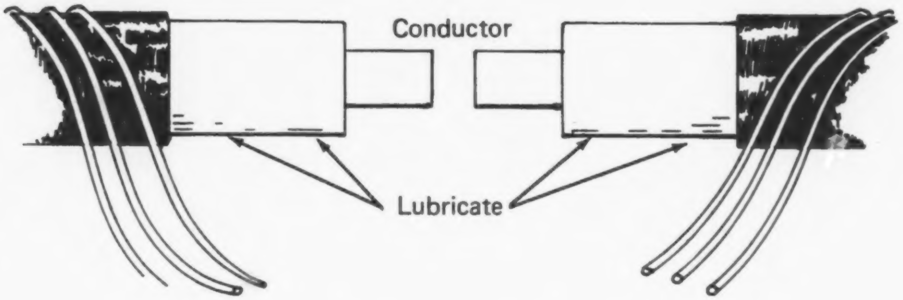

Cable Insulation
Semi-Conductor

JOB SHEET 2

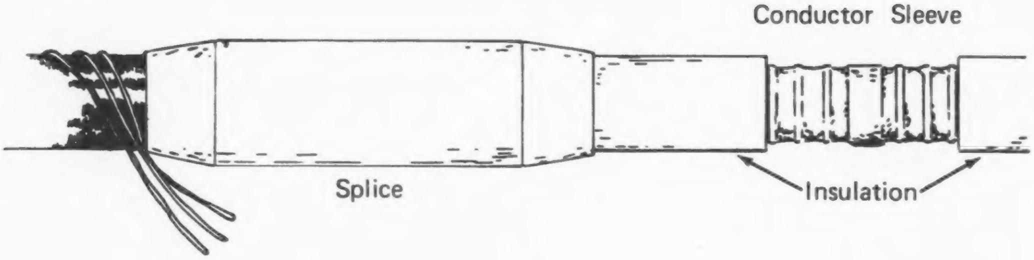
- Remove insulation and inner semi-conductor to distance specified by manufacturer

  (NOTE: Do not cut or nick conductor when removing insulation.)

- Lubricate contact area of cable with silicone grease

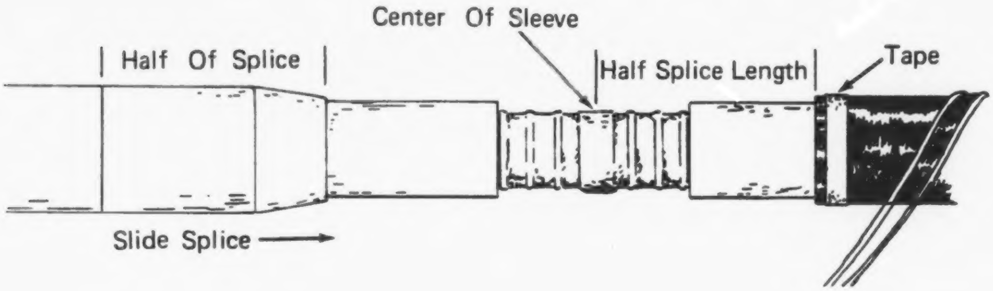

Conductor
Lubricate

- Slide splice onto cable
- Install conductor sleeve and crimp


Conductor Sleeve
Splice
Insulation

JOB SHEET 2

- Measure splice from center to end
- Measure from center of conductor sleeve to the distance of one-half the splice length; mark cable with tape


Center Of Sleeve
Half Of Splice
Half Splice Length
Tape
Slide Splice

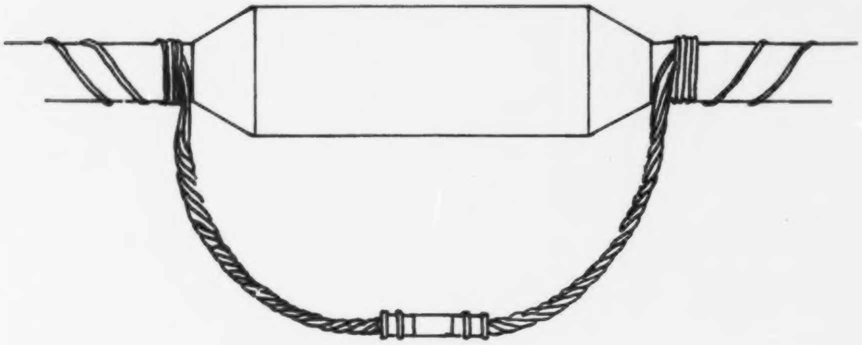
- Slide splice over conductor sleeve until end of splice reaches the tape mark; remove tape

  (NOTE: The splice must overlap the outer semi-conductor of the cable at both ends of splice.)

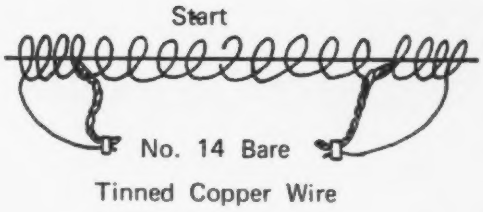
- Wrap concentric neutral back on cable to within one inch of ends of splice

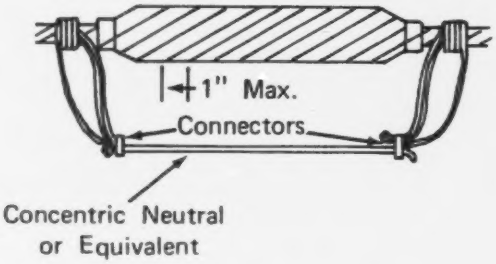
JOB SHEET 2

- Use one strand of concentric neutral to wrap around cable and concentric neutral to bond concentric neutral wires to cable



- Twist ends of concentric neutral until entire length of concentric neutral beyond wrap is tightly bound together
- Wrap entire splice in one inch or less spirals with #14 gauge bare tinned copper and bond each end of the wrap wire to the concentric neutral


Start
No. 14 Bare
Tinned Copper Wire


1" Max.
Connectors
Concentric Neutral
or Equivalent

- Connect ends of concentric neutral together.

PERSONAL CLIMBING TOOLS AND EQUIPMENT
UNIT 7

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify personal climbing tools and equipment and list inspection and maintenance procedures. The student should be able to list safety precautions to observe when climbing poles and demonstrate ability to climb poles safely. This knowledge will be evidenced through demonstration and by scoring 100 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated to personal climbing tools and equipment to the correct definitions.
2. Identify personal climbing tools and equipment.
3. Match tools and equipment to the specific use.
4. List conditions to watch for when inspecting personal climbing tools and equipment.
5. Name types of maintenance for personal climbing tools and equipment.
6. List safety precautions to observe when climbing poles.
7. Select from a list the general procedure for climbing poles.
8. Name rules for safe and proper storage of personal tools and equipment.
9. Climb poles. (Job Sheet 1)

PERSONAL CLIMBING TOOLS AND EQUIPMENT
UNIT 7

INFORMATION SHEET

1. Match terms associated to personal climbing tools and equipment to the correct definitions.

   - Body belt — Belt which is fitted to hip measurement and used to carry hand tools while working on above-ground structures
   - Safety strap — Strap used to secure a line technician working on a structure
   - Climber — L-shaped steel or aluminum strap used to climb wood structures
   - Strap — Leather or nylon band with attached buckle used to secure climber to line technician's leg
   - Pad — Leather or nylon cushion used to protect line technician's leg
   - Gaff — Metal spur attached tot he inside of climber
   - D-ring — Tested metal ring attached to either end of body belt
   - Snap — Tested metal hook with a spring-loaded safety catch which is attached to either end of safety strap
   - Gaff gauge — Measuring tool used to determine correct length, width, thickness, and shape of gaff
   - Gaff gauge kit — Correct file and handle, gauge, finishing stone, and instructions to keep gaffs in operational condition

2. Identify personal climbing tools and equipment. (Transparency 1)

   (NOTE: Use only approved tools.)

   - Climbers
   - Pads
   - Strap
   - Safety strap
   - Body belt with D-rings
   - Gaff gauge kit
   - Gaff guards

INFORMATION SHEET

3. Match tools and equipment to the specific use.

   - Climbers, straps, and pads

     1. Assist line technician in climbing wood structure
     2. Assist line technician to maintain position on wood structure

   - Body belt

     1. Holds tools
     2. Holds line technician while working on structure

   - Safety strap—Supports weight of line technician and equipment

4. List conditions to watch for when inspecting personal climbing tools and equipment.

   - Body belt

     (CAUTION: Wire hooks or metal straps shall not be attached to body belt.)

     1. Loose stitching
     2. Loose rivets
     3. Cracks in leather
     4. Hard or brittle spots in leather
     5. Cuts or tears in leather

   - Safety strap

     (NOTE: If safety strap is worn to unsafe conditions, it should be destroyed.)

     1. Worn spots
     2. Enlarged buckle holes
     3. Cuts or tears
     4. Distorted snaps
     5. Crack in snaps
     6. Weak springs in snaps

INFORMATION SHEET

        7. Loose rivets
        8. Stitching
    - Climber
        1. Worn straps
        2. Crack in metal
        3. Worn area of footpiece
    - Gaff

        (NOTE: Only proper replacement part may be used.)

        1. Length
        2. Width
        3. Thickness
        4. Shape

5. Name types of maintenance for personal climbing tools and equipment.
    - Body belt and leather equipment
        1. Clean leather with natural soap (castile)
        2. Dress leather with saddle soap and good leather dressing
    - Gaff
        1. Check with gaff gauge frequently
        2. File underside and sides to shape and sharpen

           (NOTE: The center line of the outside of the gaff should not be filed, it must retain its original straight-line shape.)

6. List safety precautions to observe when climbing poles.
    - Avoid cracks, knots, and bird holes
    - Avoid wires, steeples, and hardware
    - Avoid using braces or hardware to climb

INFORMATION SHEET

- Set both climbers securely when safetying off
- Check safety snap visually to see that it is secured in D-ring
- Do not safety off above top crossarm on distribution line
- Do not safety off on pole-top pins or other hardware
- Do not snap both ends of safety strap in one D-ring when safetying off on a structure

(NOTE: Use your climbing tools only in the manner that they were intended to be used.)

7. Select from a list the general procedure for climbing poles.

- Inspect pole for unsafe conditions

  (NOTE: Unsafe conditions include nails, pole steps, clotheslines, or other unauthorized attachments.)

- Remove rocks and other objects from base of pole
- Wear gloves and long sleeves for protection of hands and arms
- Step onto pole with gaff point directed toward center of pole
- Keep knees, hips, and shoulders away from pole
- Take short steps (6 to 8 inches)
- Remove gaff from pole by swinging knee away from pole with a breaking away motion
- Use hands and arms for balance only
- Climb with the legs
- Wear body belt and safety strap when climbing
- Take hand line up pole
- Keep gaffs properly shaped and sharp

INFORMATION SHEET

8. Name rules for safe and proper storage of personal tools and equipment.

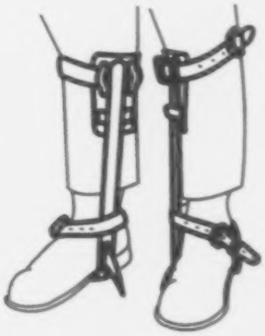
- Leather goods
    1. Store away from heat source
    2. Do not store with sharp-edged objects
    3. Store in proper area
- Climbers — Store with gaff guards on gaffs

PERSONAL CLIMBING TOOLS AND EQUIPMENT
UNIT 7

JOB SHEET 1

OBJECTIVE 9 — CLIMB POLES.

1. Tools, equipment, and materials
   - Climbers
   - Body belt
   - Safety strap
   - Gloves
   - Hard hat
   - Long-sleeved shirt
   - Hand line
   - Pole, 10 to 12 inches in diameter and 12 feet tall
   - Gaff gauge kit
2. Procedure for climbing
   - Prepare to climb
     1. Place climbers on legs, snug but not tight



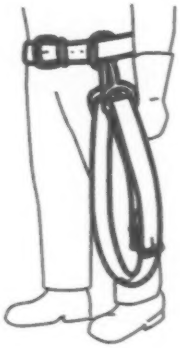
JOB SHEET 1

2. Place body belt just below waist, snug but not tight

3. Place both ends of safety strap in left D-ring

    a. Place double end of strap next to body with opening side of snap facing outward

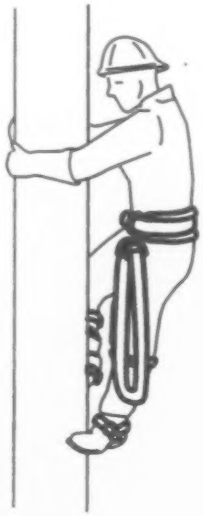
    b. Place single end of strap with opening side of snap facing inward



(NOTE: Do not let end of safety strap swing free when climbing or descending pole or when changing positions.)

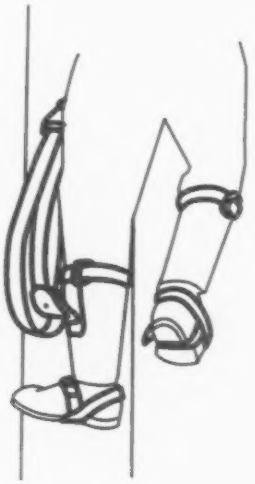
- Ascend pole

    1. Stand facing pole with knees, hips, and shoulders a comfortable distance from pole

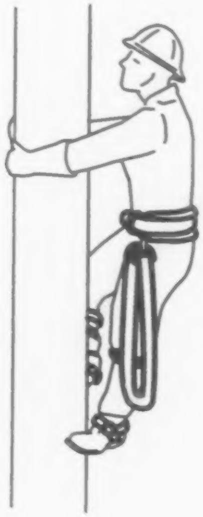


JOB SHEET 1

2. Direct gaff point of right climber toward center of pole and place gaff in pole



3. Ascend pole to 3 feet in short steps, keeping knees, hips, and shoulders away from pole

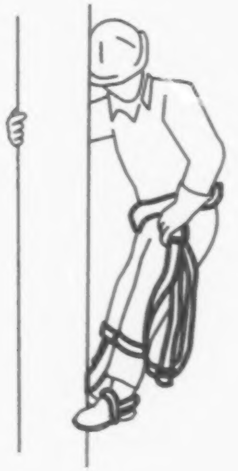


(NOTE: Use legs to climb and hands and arms for balance.)

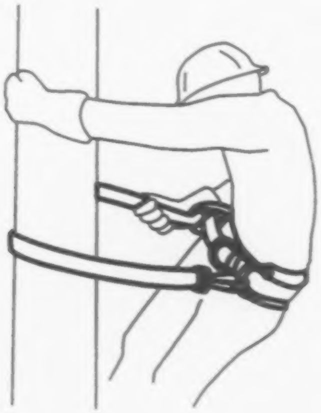
4. Place both gaffs firmly in pole

JOB SHEET 1

5. Remove single end of safety strap with left hand and place around back side of pole



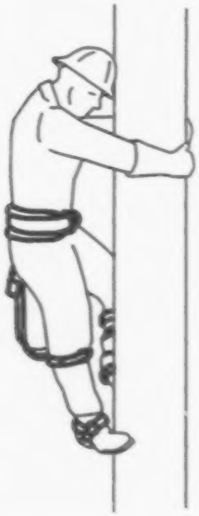
6. Take single end of safety strap in right hand and snap into right D-ring with opening side of snap facing outward; check snap visually



JOB SHEET 1

- Descend pole

1. Disconnect safety strap from right D-ring and connect to left D-ring with opening side of snap facing inward
2. Remove left climber from pole by swinging knee away from pole with a breaking away motion



3. Descend pole by lowering left foot and left hand at the same time and right hand and right foot at the same time

RIGHT-OF-WAY
UNIT 8

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify tools used for right-of-way clearing and control. The student should be able to trim a tree, remove a limb hanging over an energized conductor, and fell a tree. This knowledge will be evidenced through demonstration and by scoring 100 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with right-of-way clearing and control to the correct definitions.
2. List methods to maintain good public relations.
3. Identify tools used for right-of-way clearing and control.
4. State the purposes of right-of-way control.
5. Select from a list the safe working procedures for right-of-way clearing and control.
6. Select proper methods of tree trimming.
7. List steps to remove limb hanging over an energized conductor.
8. List steps to fell a tree.
9. State the specifications for clearing right-of-way for distribution line.
10. List types of clearing and chemical control for right-of-way.
11. Identify various trees that grow rapidly.
12. Identify poisonous vegetation.
13. Draw cuts needed to remove heavy limbs. (Assignment Sheet 1)
14. Draw procedure for removing limb hanging over energized conductor. (Assignment Sheet 2)
15. Draw procedure for felling a tree. (Assignment Sheet 3)

RIGHT-OF-WAY
UNIT 8

INFORMATION SHEET

1. Match terms associated with right-of-way clearing and control to the correct definitions.

   - Right of way—Area on which permission has been obtained to construct power lines
   - Clearing—Removal of trees and shrubs from right-of-way
   - Control—Restrict or remove new growth from right-of-way
   - Clearance—Recommended distance which should be maintained between conductors and growth
   - Safety sling—Rope used to secure climber to tree while removing limbs
   - Underbrush—Shrubs, bushes, or small trees growing beneath large trees
   - Outage—Interruption of electric service
   - Power loss—Current not metered or sold to the consumers

2. List methods to maintain good public relations.

   - Obtain permission

     (NOTE: No trimming or clearing should be done before written permission is obtained from property owner.)

   - Be sure owner understands what work is to be done
   - Dispose of brush by burning, chipping, or hauling away according to landowner's wishes

     (NOTE: Brush may be placed in nearby washes or ditches to aid in preventing erosion.)

   - Respect owner's property rights

     (NOTE: Do not leave gates open or damage lawns or shrubs with equipment. Clean area thoroughly before leaving.)

INFORMATION SHEET

3. Identify tools used for right-of-way clearing and control. (Transparency 1)

   (NOTE: In addition to the following tools, the trimmer will need a one-half inch thick polyester rope and spray or brush type tree wound paint.)

   - Power saw
   - Hand saw
   - Long-handled trimmer
   - Pruner
   - Axe
   - Climber's saddle
   - Chipper

     (NOTE: Brush chips are thrown from chute on chipper into a truck.)

   - Sprayer

     (NOTE: Some chemicals may require protective equipment which may include but is not limited to respirators, latex or vinyl gloves, and face protection.)

4. State the purposes of right-of-way control.

   - Prevent electric service outages
   - Prevent damage to conductors
   - Reduce power loss

     (NOTE: Power loss can be substantial if trees or shrubs are allowed to grow into energized conductors.)

   - Allow access to electrical system

5. Select from a list the safe working procedures for right-of-way clearing and control.

   - Post "Working" signs when working near streets or highways
   - Rope off or barricade area to protect the public
   - Park vehicles a safe distance from work area
   - Check condition of all tools before use

INFORMATION SHEET

- Check for overhead power lines

  (NOTE: See current OSHA rule for tree trimmers.)

- Climb into tree with a ladder

  (NOTE: Tree climbing tools should not be used on a tree that is not going to be removed.)

- Use safety sling while trimming tree (Transparency 2)
- Use power saw below shoulder level only
- Do not use power saw while working in a tree
- Keep a separation of at least 10 feet between persons cutting brush
- Use axes and hatchets for ground level work only
- Wear eye protection
- Wear rubber gloves and rubber sleeves with protectors when working near energized conductors

6. Select proper methods of tree trimming. (Transparencies 3 and 4, Assignment Sheet 1)

   - Start first cut on bottom side of limb
   - Start second cut on top side of limb

     (NOTE: Small branches may be removed with only two cuts. Four cuts are necessary to remove large side limbs.)

   - Slope cut on vertical limbs for good drainage
   - Remove limb flush with trunk

7. List steps to remove limb hanging over an energized conductor. (Transparency 5, Assignment Sheet 2)

   - Tie butt rope to limb near cut
   - Tie fall rope near outer end of limb
   - Tie guide rope at outer end of limb
   - Extend butt and fall ropes upward and through separate forks in limbs above limb to be removed

INFORMATION SHEET

- Extend guide rope to ground
- Use insulated link sticks
- Tie butt and fall ropes to tree trunk
- Secure climber with safety rope
- Cut limb and swing it away from conductor with guide rope
- Lower limb with butt and fall rope

8. List steps to fell a tree. (Transparency 6, Assignment Sheet 3)

    - Saw or chop a V-shaped notch 1/4 way through trunk on the side which the tree should fall
    - Saw through tree from opposite side of not
    - Use rope to guide tree in direction needed

9. State the specifications for clearing right-of-way for distribution line. (Transparency 7)

    - Center of pole line to growth—10 feet
    - Total width of clearing—20 feet
    - Minimum distance between conductors and growth—6 feet (Transparency 4)

    (NOTE: Right-of-way for transmission line will vary in width according to type of structure used.)

10. List types of clearing and chemical control for right-of-way.

    - Clearing
        1. Hand-operated equipment
        2. Motorized equipment
    - Chemical
        1. Hand sprayer
        2. Aerial spraying

INFORMATION SHEET

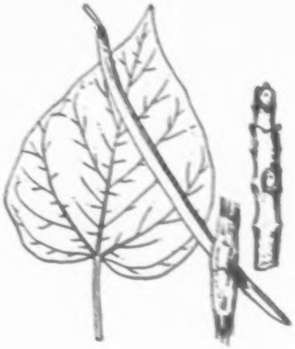
3. Pellet application

(NOTE: Chemicals used for brush control will kill all woody-stemmed plants. Care should be taken not to spray when wind will blow chemicals into cotton fields or on other broadleaf or woody-stemmed plants. See the appropriate MSDS.)

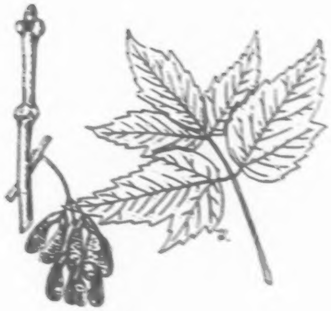
11. Identify various trees that grow rapidly.

(NOTE: The following trees grow more rapidly than most trees and should be cut back as much as the owner will allow to prevent annual trimming.)

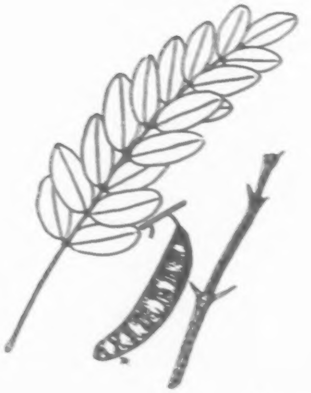
- Catalpa



- Box elder

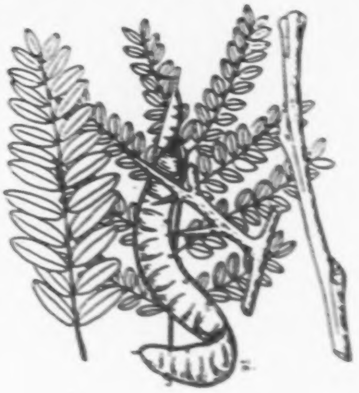


- Black locust

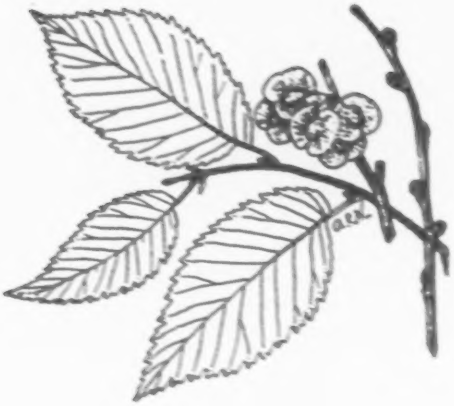


INFORMATION SHEET

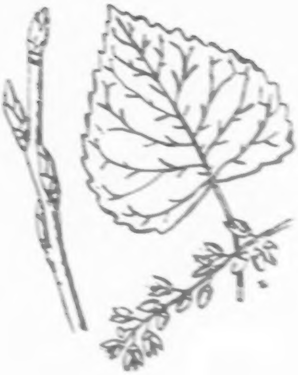
- Honey locust

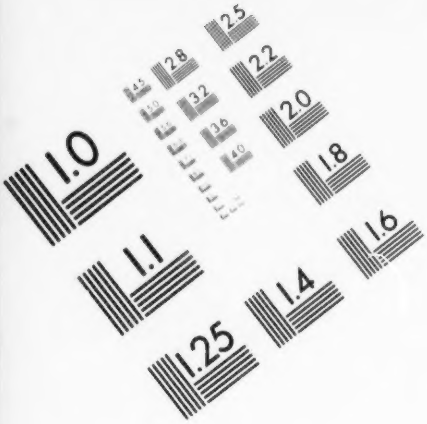


- Chinese elm



- Cottonwood





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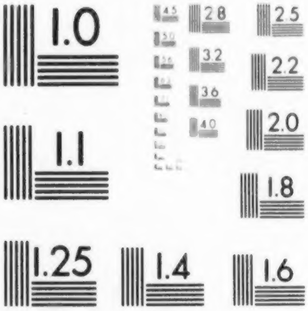

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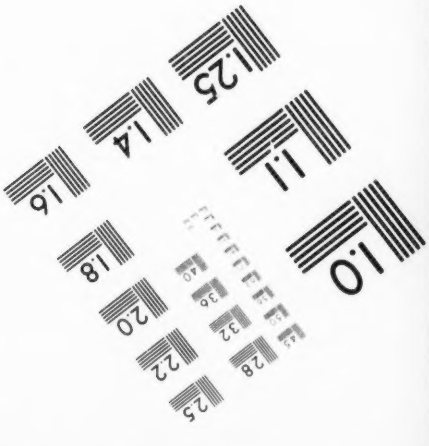

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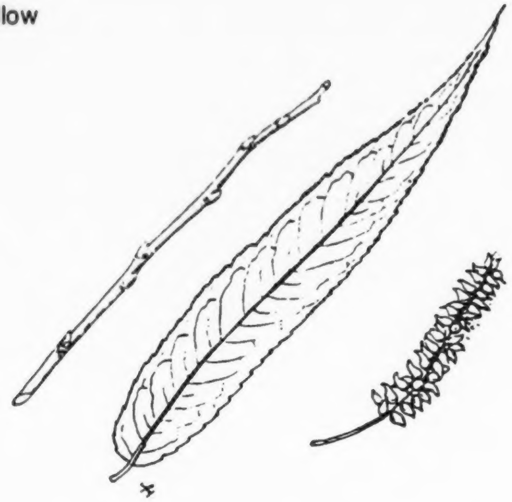
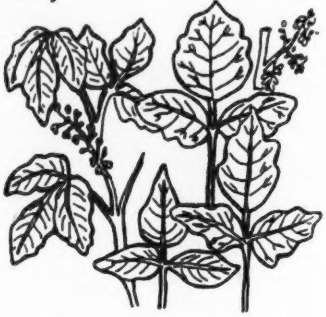
- Black willow

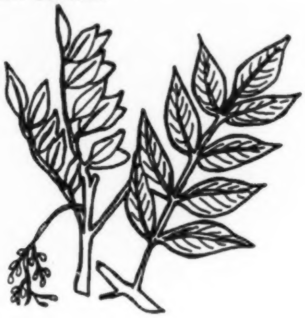


12. Identify poisonous vegetation.

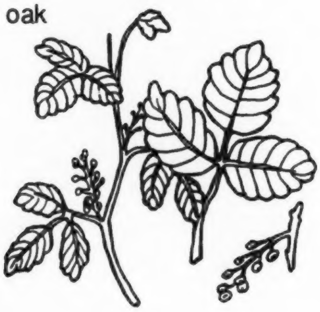
- Poison ivy



- Poison sumac



- Poison oak

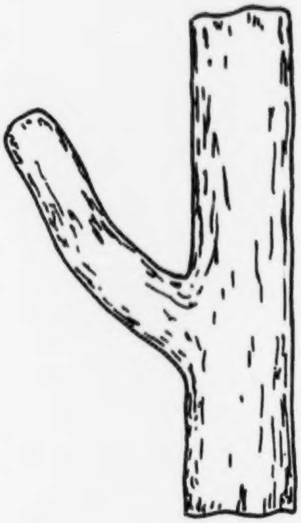


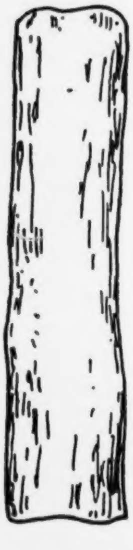
RIGHT-OF-WAY
UNIT 8

ASSIGNMENT SHEET 1

OBJECTIVE 13 — DRAW CUTS NEEDED TO REMOVE HEAVY LIMBS.

Use the following drawings to indicate the number and location of each cut needed to remove heavy side and vertical limbs.



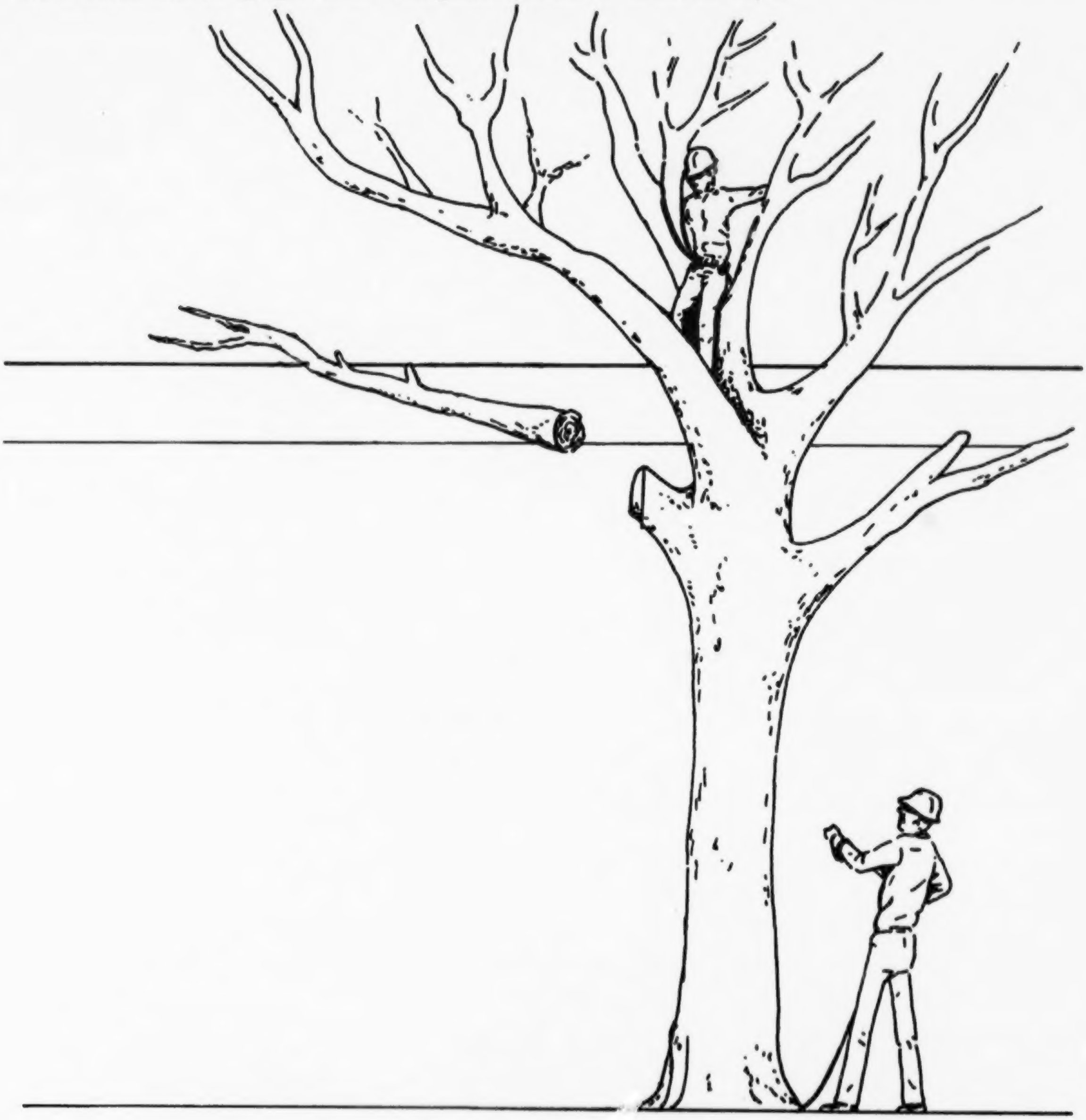


RIGHT-OF-WAY
UNIT 8

ASSIGNMENT SHEET 2

OBJECTIVE 14 — DRAW PROCEDURE FOR REMOVING LIMB HANGING OVER ENERGIZED CONDUCTOR.

Use the illustration below to draw in the ropes necessary to secure the climber and to safely lower the severed limb hanging over the energized conductor. Label the ropes.

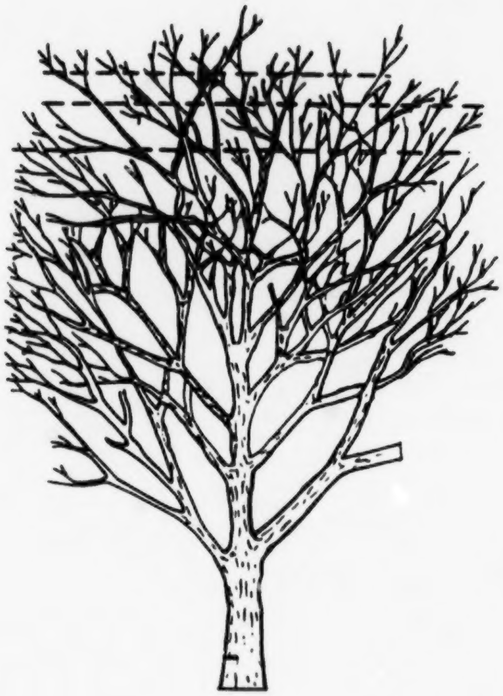


RIGHT-OF-WAY
UNIT 8

ASSIGNMENT SHEET 3

OBJECTIVE 15 — DRAW PROCEDURE FOR FELLING A TREE.

Use the following drawing to indicate the number and location of each cut and the manner of applying force to fell the tree *to the right.*



DISTRIBUTION TRANSFORMERS
UNIT 9

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of a completely protected transformer and classify types of transformers as air-cooled or oil-cooled. The student should be able to record information found on a transformer nameplate and complete a transformer record sheet. This knowledge will be evidenced through demonstration and by scoring 100 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with transformers to the correct definitions.
2. State the functions of a transformer.
3. Identify parts of a completely protected transformer.
4. Distinguish between additive and subtractive polarity as they relate to transformers.
5. List kinds of transformers.
6. Match types of transformers to the correct descriptions.
7. Classify types of transformers as oil-cooled or air-cooled.
8. Discuss technical considerations in protective grounding and jumpering.
9. List information found on a transformer nameplate.

DISTRIBUTION TRANSFORMERS
UNIT 9

INFORMATION SHEET

1. Match terms associated with transformers to the correct definitions.

- Transformer tank — Metal enclosure which houses the transformer core, coils, and cooling oil
- High - Voltage bushing—Bushing made of porcelain or other nonconductive material which insulates high voltage from the transformer tank
- Low-voltage bushing — Bushing made of nonconductive material which insulates the low voltage from the transformer tank
- Completely protected transformer — Transformer which has a high voltage lightning arrester, primary fuse, and a built-in low voltage circuit breaker
- Conventional transformer (type "S") — Transformer installed with only an internal fuse for protection

  (NOTE: Conventional transformers may have more than one high-voltage bushing.)

- Core and coil assembly — Unit composed of primary and secondary windings on a laminated metal core
- kVA (kilovolt-ampere) — Rating of a transformer

  (NOTE: kVA is the apparent power rather than the true power. kVA is found by multiplying the secondary voltage by the full load amperes and dividing by 1000.)

- Impedance — Opposition to current flow in an alternating current circuit
- Primary winding — Winding to which voltage is applied
- Secondary winding — Winding from which voltage is taken
- Transformer record — Printed form used to record information from transformer
- Tap changer — Unit in some transformers which increases or decreases the number of turns on the primary winding
- Transformer oil — Oil used in transformer tank to insulate and cool core and coil assembly

INFORMATION SHEET

- Transformer-turns ratio — Turns on the primary winding related to turns on the secondary winding; the ratio between the primary and secondary voltage ratings

  Example: 7200 volt primary 120 volt secondary
  7200 ÷ 120 = 60
  Ratio = 60 to 1

- Polarity — Indicates direction of current flow through the primary winding with respect to the direction of current flow through the secondary winding

- Grounding — A conducting connection between an electric circuit or equipment and the earth, or to some conducting body that serves in place of the earth

- Jumpering — The use of low resistance conductors to bypass a work area

- Step potential — The voltage between the feet of a person standing near an energized grounded object. It is equal to the difference in voltage, given by the voltage distribution curve, between two points at different distances from the "electrode".

- Touch potential — The voltage between the energized object and the feet of a person in contact with the object. It is equal to the difference in voltage between the object (which is at a distance of 0 feet) and a point some distance away.

2. State the functions of a transformer.

   - Transfers current from one circuit to another with no physical connection

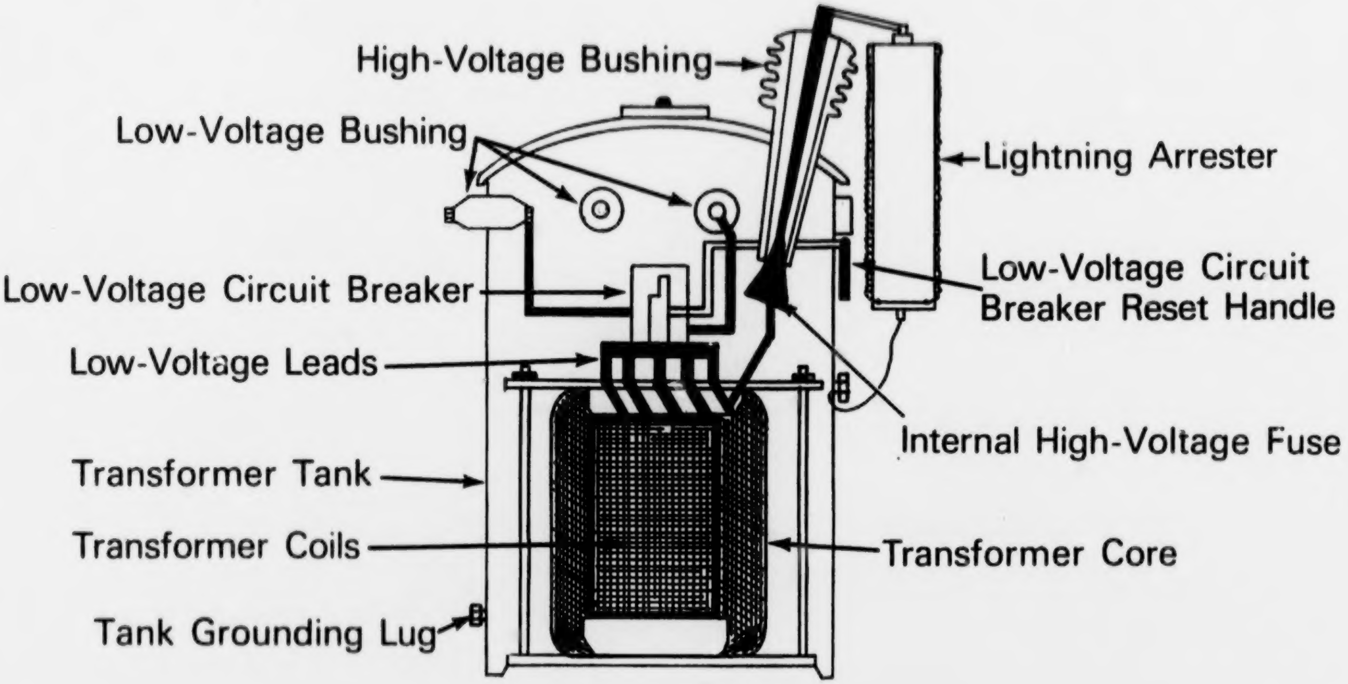
   - Transforms voltage from high voltage to low voltage

     Example: Step-down transformer

   - Transforms voltage from low voltage to high voltage

     Example: Set-up transformer

3. Identify parts of a completely protected transformer. (Transparency 1)


High-Voltage Bushing
Low-Voltage Bushing
Lightning Arrester
Low-Voltage Circuit Breaker
Low-Voltage Circuit Breaker Reset Handle
Low-Voltage Leads
Internal High-Voltage Fuse
Transformer Tank
Transformer Coils
Transformer Core
Tank Grounding Lug

INFORMATION SHEET

4. Distinguish between additive and subtractive polarity as they relate to transformers.

    - Additive polarity — The H and X lead connections are arranged causing the total induced voltage to be greater than the primary. The sum of the primary and secondary voltages are additive because the polarities are the same.

    - Subtractive polarity — The H and X lead connections are arranged causing the total induced voltage to oppose each other and thus the secondary induced voltage is subtractive from the primary voltage.

5. List kinds of transformers.

    - Oil-cooled

    - Air-cooled

6. Match types of transformers to the correct descriptions.

    - Pole mount — Oil-cooled transformer with side-mounted hangers installed on a pole

    - Pad mount — Oil-cooled transformer installed on a plastic or concrete pad in commercial or residential underground distribution system

    - Submersible — Oil-cooled transformer installed in a concrete or fiber vault for residential distribution

    - Potential transformer — Air-cooled transformer used to reduce voltage for testing or metering purposes

    - Current transformer — Air-cooled transformer used with metering equipment

    (NOTE: Potential and current transformers are sometimes referred to as *instrument transformers.*)

INFORMATION SHEET

- Autotransformer—Oil-cooled transformer in which the primary and secondary have a common winding

  (NOTE: Autotransformers are most efficient when the voltage difference between the primary and secondary is not great.)

7. Classify types of transformers as oil-cooled or air-cooled. (Transparencies 3 and 4)

- Oil-cooled
  1. Pole mount

     Example: completely protected or conventional
  2. Pad mount
  3. Submersible
  4. Autotransformer
- Air-cooled
  1. Potential
  2. Current
     a. High voltage
     b. Low voltage

8. Discuss technical considerations in protective grounding and jumpering.

- Grounding and jumpering use
  1. Protection of people from electric shock
  2. Applicable to work at transmission voltages, overhead and underground distribution, in substations and with trucks
- Methods of grounding and jumpering
  1. Temporary protective grounds

     (NOTE: Shall be placed at such locations and arranged in such a manner as to prevent persons from being exposed to hazardous difference in electrical potential.)

INFORMATION SHEET

2. Attach worksite safety jumper to the structure just below the worker's feet to provide a safe work zone

3. Use system neutrals and static wires in parallel with driven grounds

   (NOTE: Never use neutrals and static wires alone.)

4. Use protective mats

- Step and touch potential (Transparency 5)

  1. Voltage-Gradient Distribution Curve (Transparency 6)

  2. Resistance

     (NOTE: Varies with the amount of soil moisture, salts present, temperature and type.)

  3. Equipotential Zone (Transparency 7)

- Single point versus double point grounding

  1. Single point grounding places a safety jumper on the work tower only

  2. Double point grounding places jumpers on the tower on either side of the work tower

- Equipment requirements

  (NOTE: Should be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault. Should have an impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the lines or equipment.)

  1. Clamps

     (NOTE: Use adequate clamps, both from a mechanical strength and current carrying standpoint.)

  2. Cable

     (NOTE: Cable fusing curves should be consulted for cable selection. Clear jacketed cable is recommended because it can be frequently checked for strand breakage.)

INFORMATION SHEET

3. Connections

   (NOTE: Use clean, low resistance connections. Always apply the ground connection first.)

   a. Ground rod

      (NOTE: Must be driven deep enough to penetrate moist soil all year round—usually 8 feet or more.)

   b. Steel water main

9. List information found on a transformer nameplate. (Assignment Sheet)

Your instructor will show you an example of a transformer nameplate. In the blanks below, list the information found on the nameplate.

(NOTE: This information is needed when installing, removing, or changing a transformer.)

- ____
- ____
- ____
- ____
- ____
- ____
- ____
- ____
- ____
- ____

(NOTE: Most cooperatives and utilities put their own numbers on transformers. This is also part of the information needed.)

A CIMC "RAINBOW PROGRAM"

FOR STANDARDS OF TEACHING EXCELLENCE

One very important factor contributing to higher student performance is the expectation of parents and teachers. Experience suggests that teachers and parents who expect student success find that students perform better, attend class more regularly, have positive attitudes, and stay in school longer. The students' success and confidence in their ability to learn may cause additional growth and behaviors that exert a positive influence throughout life.

STUDENT'S PROMISE

Let it be publicly known that students in this program have high expectations of

I recognize that America's future is dependent
 on my success in school.
I will attend school regularly.
I will keep regular study hours at home.
I will read each day at home.
I will never accept failure.
I will accept responsibility for my school challenges.
I will respect the rights and feelings of others at home,
 school, and work.
I will develop positive qualities in myself that my friends
 will admire.
If I have difficulty, I will insist on help with my school work.
If I have difficulty, I will always try harder.
I will ask my teacher for clear learning objectives.
I will practice good citizenship skills at home, school, and work.
I will keep my parents/guardians informed daily about
 my school activities.
I will develop goals for school, home, and work.
I will seek advice from my teachers, parents/guardians, and
 counselors on career guidance.
I will constantly practice the skills of a good student.

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